Science and Mathematics Education Centre

Laboratory Learning Environments and Teacher-Student Interaction in Physics Classes in Thailand

Toansakul Santiboon

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ABSTRACT

This study describes students' perceptions of their physics classroom learning environments and their interactions with their teachers in upper secondary school classes in Thailand. Associations between these perceptions and students' attitudes toward physics were also determined. The learning environment perceptions were obtained using the 35-item *Physics Laboratory Environment Inventory* (PLEI) modified from the original *Science Laboratory Environment Inventory* (Fraser, McRobbie, & Giddings, 1993). Teacher-student interactions were assessed with the 48-item *Questionnaires on Teacher Interaction* (QTI) (Wubbels & Levy, 1993). Both these questionnaires have an Actual Form (assesses the class as it actually is) and a Preferred Form (asks the students what they would prefer their class to be like - the ideal situation). Students' attitudes were assessed with a short Attitude scale. The questionnaires were translated into the Thai language and administered to a sample of 4,576 students in 245 physics classes at the grade 12 level. Statistically significant differences were found between the students' perceptions of actual and preferred environments and teacher interpersonal behaviour in Thailand. Associations between students' perceptions of their learning environments and teachers' interpersonal behaviour with their attitudes to their physics classes also were found. It was found from interviews with a sub-sample that particular categories of comments could be identified, physics being a difficult subject, evaluation and assessments not being related to the tertiary entrance examination, and teachers' plans. These factors appear to be affecting student achievement in physics. Based on all the findings, suggestions for improving the physics laboratory classroom environment and teacher interpersonal behaviour with students' perceptions are provided.

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CHAPTER 1

INTRODUCTION AND OVERVIEW

1.1 INTRODUCTION

In 1972, the Institute for the Promotion of Teaching Science and Technology (IPST) in Thailand was established in order to develop a national science and mathematics curriculum at the secondary school level (grades 7-12). Thailand had been using the 1960s versions of the science and mathematics curricula prior to that time. This early curriculum was composed only of a syllabus and course description, while private publishers wrote textbooks and practical manuals. Upper secondary schools were able to choose teaching materials according to the preferences of their teachers and the facilities available.

The physics curriculum for upper secondary level was divided into five parts but there were six textbooks, namely, Mechanics, Heat, Light, Sound, Electricity and Magnetism. Schools could choose three subjects from the list of five options. At that time in the 1960s, the universities entrance examination for physics was prepared to cover the five topics. Students, who sat for the entrance test, especially in a science stream, were allowed to select three topics from the five, depending on the topics they learned in school.

After the IPST had been established, the multi-part physics course was combined into a unified physics course that was mostly influenced by Harvard Project Physics. Not only were the theoretical details combined together, but the practical work was also grouped within the textbook by using an inquiry and experimental approach. Prior to this, the theory and practical parts of physics were quite separate. Following the implementation of the new science curriculum in 1976, laboratory experimentation in physics has been incorporated within most of the teaching programs of upper secondary school teachers in Thailand.

There are many factors, such as the university entrance examination and teacher workloads that now affect the teaching and learning of science carried out in secondary schools. From the follow-up projects developed by the IPST, the decreasing use of an experimental approach in physics classes in many schools is obvious (Evaluation and Research Team of the IPST). This is in spite of the fact that the country spent a considerable amount of its budget producing the new physics curriculum and providing equipment for all upper secondary schools. The lack of utilization of the equipment affects not only the national education target, but also negatively influences the attitudes of the students toward science, especially, physics.

Since 1982, the physics design team of the IPST has prepared achievement tests to evaluate the performance of upper secondary students in some selected schools. The items in these tests deal with many aspects such as problem solving, laboratory knowledge, and science process skills. However, the results from such tests were not satisfactory, even though the difficulty of the items was pitched at an average level. This phenomenon is no doubt due to the many factors which affect the achievement of students in physics such as the teacher, the curriculum, university entrance examinations, students' ability, and students attitude toward physics. However, the IPST team improved the physics curriculum again in 1997 and divided it into two structural curricula for each upper secondary school to choose only one.

1.2 WHY ENCOURAGE THE USE OF THE PLEI AND THE QTI IN THE CLASSROOM?

Not only is Thailand in the third world of development, its science education is also in the third world, especially physics education. With the cooperation of the IPST, the faculties of science, technology and education of the universities and the Rajabhat Institutes, the Ministry of Science, Technology and Energy, and the General Secondary School Department of the Ministry of Education of Thailand, 1,256 physics teachers who were teaching in upper secondary school were assessed and evaluated using standardised-test of physics in April, 2003. According to the findings of this study, none of the physics teachers could pass at the designated critical level. At the same time, the physics students who were studying at the grade

12 level, in 2002, in Thailand, were assessed and evaluated by a standardized physics test. The findings of this study indicated that the mean score of the physics test was 30% and the physics skills in experiment part were 25% (IPST News, 2003). Further to this crisis situation it has been estimated that one to five percent of all physics teachers are not valued or treated as professionals by their school leaders.

1.3 THAILAND'S EDUCATION SYSTEM

1.3.1 Historical Educational System Background

The kingdom of Thailand is situated in Southeast Asia, and is referred to as the golden axe. The country has a total area of 511,770 square kilometres, an estimated population of around 62,000,000, of which 80% are Thai, and 20% are Chinese, Muslim, and indigenous people. Thai people enjoy a reasonable standard of living, which includes tax-free personal income, rents, royalties, taxes and dividends, but receive little or no social support, for example, unemployment benefits from the Thai government. Whilst Thailand is economically dependent on the production of agriculture (56.7%), a series of five-year national development economic plans have been used to diversify its performance in many fields, such as education. The ninth plan began in 2002. The religion of 90.3% of the Thai population is Buddhist, and 9.7% is Christian and Muslim. Ninety two percent of the population speaks the Thai language.

In Thailand, education is free for all citizens from the primary to the secondary level (grade 1-12) in government schools. Students can select to attend either government schools, which are administered by the Ministry of Education, or private schools, which are funded by different communities, but work directly under the Ministry of Education. The school system consists of the three stages of primary education, secondary education, and higher education. Students attend primary education for six years, which includes two years of pre-schooling. Science is a part of the "Effort experience of life" subject, which is one of four subjects (Mathematics, Thai language, Work of life, and Effort experience of life). However, science is emphasized more in the lower secondary school level and is divided into physics, chemistry and biology in the upper education school. Each school pays different attention to content, teaching and learning activities, but the educational policy comes from the government. Students study science for four periods a week. At the upper secondary school level the weighting of science each week is three periods for physics, four periods for biology, four periods for chemistry and one period for the natural environment subject.

1.3.2 The 1992 National Scheme of Education

During the past four decades, there have been some changes in the principles and concepts, including policies and objectives of Thai education as the society and economy have begun to change and become more complex. An evolution in principles and concepts of education can clearly be seen in the *National Scheme of Education* and the *National Education Development Plan.* At present, Thai education has been provided in accordance with the *1992 National Scheme of Education* and the *Ninth National Education Development Plan* (2002-2006), which reflects the principles, concepts as well as policies and objectives, of education as presented in the following sections. A summary of the principles and goals of education including the policy directives stated in the present *National Scheme of Education* (NSE) is provided in Appendix A.

Figure 1.1 shows the geographic location of Thailand in which, there is five geographical regions, 76 provinces, 13 educational regions, and 175 educational reform areas.

Thus, Thai education is now provided on the basis of the 1992 National Scheme of Education, a long-term plan, and the Eighth and the Ninth National Education Development Plans (1997-2001 and 2002-2006), which are five-year plans, and contain educational objectives and policies to be implemented by operational units during these periods.

1. BANGKOK	กรุงเทพมหานคร	7. PATHUM THANI	ปทุมธานี
2. SAMUT PRAKAN	สมุทรปราการ	8. NAKHON NAYOK	นครนายก
3. SAMUT SAKHON	สมุทรสาคร	9. AYUTTHAYA	พระนครศรีอยุธยา
4. SAMUT SONGKHRAM	สมุทรสงคราม	10. ANG THONG	อ่างทอง
5. NAKHON PATHOM	นครปฐม	11. SING BURI	สิงห์บุรี
6. NONTHABURI	นนทบุรี		

Figure 1.1. Educational regions in Thailand (Thaiways web site)

1.4 BACKGROUND OF THE STUDY

Thirty Nine Percent of the Thai population are aged between 6 and 24 years and are studying in formal, non-formal, and independent education systems. In total, there are about 15.7 million students studying in these educational systems. Of these students, 1.5 million are at the upper secondary level (grades 10-12). The students need to compete with one another to enter the 24 government universities, but only 20% out of approximately 120,000 students are able to pass and study at these universities. It is for this reason that 80% of all tertiary students in Thailand study at the other Rajabhat universities, vocational colleges, private universities and open universities.

Table 1.1 provides the results from the entrance examination reports from the Ministry University Office and shows the average mean scores of the eight subjects in the three academic years 2000 to 2002.

Table 1.1
The Average Mean Score Percentages of the Students Who Sat for Entrance Examinations from 2000 to 2002

Code subject	Subject types	Average Mean Scores in each academic year		
		2000	2001	2002
01	Thai language	42.72	41.65	45.52
02	Social science	40.28	38.76	44.80
03	English	32.42	39.87	39.76
04	Mathematics 1	24.46	24.66	25.48
05	Chemistry	24.71	25.75	29.54
06	Physics	24.30	24.12	23.45
07	Biology	32.54	30.82	35.31
16	Engineering foundation	27.35	27.13	33.21
		N = 126,438	N = 124,735	N= 121,943

Source: University Ministry reported (April 21, 2002)

What happens to the physics students in Thai education who study at the upper secondary level at schools in Thailand but obtain the lowest average mean scores?

Why do the students get the lowest average scores of all subjects in physics in the entrance examination to the government universities every academic year in Thailand?

The International Physics Olympiad (IPhO) was found around 30 years ago in Eastern Europe but it was not until the early 1980s that Western Countries began to participate, first Germany then UK, USA and Canada. The competition is for teams of five students, none of whom have yet entered University. Individual competitors sit for intensive practical and laboratory examinations. For their efforts, the students can be awarded gold, silver or bronze medals or honourable mentions. The competition was held with over 250 of the world's best physics students from over 51 nationals competing at the equivalent of the "Olympic games for Physics". Thai students first participated in the 1990 at competition.

The report of the Institute for Promotion of Teaching Science and Technology of Thailand (IPTS) on the results of the Olympic Games for Physics Competition is shown in Table 1.2

The participating student are the highest ranked physics students in Thailand but, as Table 1.2 indicates, Thai students are consistently placed in the lower percentile over the years of competition. Is this a result of Physics teachers' poor ability in teaching the material? Is the result related to classroom environment or is it the students' inability to comprehend the material being presented? Could it be teacher-student relationships that are causing this less than average performance of the students in physics? Are the problems related to the classroom environment, the students' perceptions of teacher-student interactions, laboratory climate, curriculum framework, unsatisfied content, assessing classroom environment, or communication of teachers' teaching? These are the many questions that come to mind. What are the solutions and answers to these problems? This research study will focus on the classroom environment aspect. The researcher believes that these two reports above reveal are the most important problems in Thai education.

Table 1.2

The Results of the Olympic Games for Physics Competitions for Thai Students

Year of Thai students Participation	Year of Olympic Physics Competition	Number of Thai's students Competing	Number of Countries Participating	Ranking of Thai's students
1990	21st	1	32	25
1991	22nd	2	31	23
1992	23rd	3	37	37
1993	24th	4	41	30
1994	25th	5	47	24
1995	26th	6	51	42
1996	27th	7	56	33
1997	28th	8	56	31
1998	29th	9	55	32
1999	30th	10	62	40
2000	31st	11	62	46

Source: IPST (2002).

1.5 USE OF LEARNING ENVIRONMENT INSTRUMENTS

In the last decade, many countries have used learning environment instruments in conducting research studies. Some examples of these are the *Science Laboratory Environment Inventory* (SLEI) which was developed with Australian secondary school students (Fraser, 1991) and was extensively validated in diverse country settings such as, the USA, Australia, Canada, England, Israel, Nigeria, Brunei, Singapore, South Korea and the counties in South Pacific Islands (Fraser, Giddings & McRobbie, 1995; Giddings & Waldrip, 1996; Lee & Fraser, 2001; Wong & Fraser, 1996). Laboratory work is seen as an integral part of most science courses, especially physics courses, and creates an environment different in many ways from that of the traditional classroom. It was decided to investigate physics laboratory environments in this study.

The *Questionnaire on Teacher Interaction* (QTI) was originally an instrument in the Dutch language developed for use in a teacher education in Holland (Creton, Hermans, & Wubbels, 1990; Wubbels, Brekelmans & Hooymyers, 1991; Wubbels & Levy, 1993). It has also been used in USA (Wubbels & Levy, 1991), Singapore (Fraser & Chionh, 2000), India (Walberg, Singh, & Rasher, 1977), Taiwan (Aldridge & Fraser, 1997; Aldridge, Fraser, & Huang, 1999), Brunei (Asghar & Fraser, 1995; Riah & Fraser, 1998), Indonesia (Soerjaningsih, Nusantara, Fraser, & Aldridge, 2001), and cross-national studies of science classroom environments (Fisher, Rickards, Goh, & Wong, 1997; Rickards, Riah, & Fisher, 1997). However, these instruments are yet to be used in Thailand in research studies. Therefore, it was considered appropriate and helpful to select convenient questionnaires that could be used to investigate the nature of physics classroom and environments.

A distinctive feature of most of the instruments is that they have, not only a form to measure perceptions of 'actual' or experienced classroom environment, but also another form to measure perceptions of 'preferred' or ideal classroom environment. The preferred forms are concerned with goals and value orientations and measure perceptions of the classroom environment ideally liked or preferred. Although item wording is similar for actual and preferred forms, slightly different instructions for answering each are used. For example, an item in the actual form such as 'There is a clear set of rules for students to follow' would be change in the preferred form to 'There would be a clear set of rules for students to follow. An investigation of differences between students and teachers in their perceptions of the same actual classroom environment and of differences between the actual environment and that preferred by students or teachers was reported by Fisher and Fraser (1983) using the ICEQ in Australia with a sample of 116 classes for comparisons of student actual with student preferred scores and a sub-sample of 56 of the teachers of these classes for contrasting teachers' and students' scores. Students preferred a more positive classroom environment than was actually present for all five environment dimensions.

The two instruments selected for uses in this study were the *Questionnaire on Teacher Interaction* (QTI) and the *Science Laboratory Environment Inventory* (SLEI). One of the reasons for selecting these instruments was because the author conducted a small project on encouraging physics teachers to assess the environments of physics classrooms and laboratories and to inform physics teachers of activities which could be utilized in order to improve students' achievement and outcomes. This project was conducted with 383 students in 11 classes of nine different programs in two semesters in the academic year 2001. The results showed that there were associations between students' perceptions of the physics classroom learning environment as measured by the scales of the QTI, and students' perceptions of their laboratory classes as measured by the scales of the SLEI. In this study the SLEI was modified to the Physics Laboratory Environment Inventory (PLEI) to make it more suitable to the physics laboratory. The questionnaires are described in detail in later chapters.

1.6 RESEARCH QUESTIONS

The overall aim of this study was to describe the determinants and effects of students' perceptions of physics classroom environments in upper secondary school classes in Thailand, in order to improve the performance of students in physics. But the PLEI and the QTI questionnaires had not been used in physics classes in Thailand before this study; therefore, the validation of these questionnaires formed the focus of the first and the second research questions.

> Research Question 1: Is the Physics Laboratory Environment Inventory (PLEI) a valid and reliable instrument for use in Thailand?

> Research Question 2: Is the Questionnaire on Teacher Interaction (QTI) a valid and reliable instrument for use in Thailand?

As this was the first study to measure physics classrooms students' perceptions of both teacher interpersonal behaviour and classroom laboratory environment in physics classrooms in Thailand, a comparison between actual and preferred students' perceptions was thought important. This formed the focus of the next two research questions.

Research Question 3: Are there any differences between the students' perceptions of their actual and preferred teacher interpersonal behaviour in physics classes in Thailand?

Research Question 4: Are there any differences between the students' perceptions of their actual and preferred classroom laboratory environments in physics classes in Thailand?

It was also considered important to investigate associations between students' perceptions of teachers' interpersonal behaviour and learning environments with their attitudes to their physics classes. This formed the focus of research questions five and six.

Research Question 5: What associations are there between students' perceptions of their teachers' interpersonal behaviour in physics and their attitudes toward physics?

Research Question 6: What associations are there between students' perceptions of their physics laboratory classroom environments and their attitudes toward physics?

Finally, it was considered important to discover what opinions the students had about their physics laboratories and experimentation as this was suspected to be one of the factors that affected student achievement in physics.

Research Question 7: What are the students' opinions about the situation of physics having the lowest average score at the grade 12 level in Thailand?

1.7 SIGNIFICANCE OF THE STUDY

The study is significant for three reasons. First, it is likely to provide information for explaining the students' low average mean scores on physics, the lowest of all subjects in the entrance examination for the universities every academic year. Second, it will provide physics teachers with a strategy for using the PLEI in attempts to improve laboratory class environment and using the QTI in attempts to improve teacher-student relationships in physics classes. The thesis is likely to result in improved student attitudes to physics if teachers aim to promote both student achievement and attitude to improve student outcomes. Third, the study is likely to contribute to learning physics in the thirteen educational regions of Thailand, where there are 4,576 students and learning physics in 245 physics secondary school classes at grade 12 level among the 120,000 students who are attending schools in Thailand.

1.8 OVERVIEW OF METHODOLOGY

The Physics Laboratory Environment Inventory (PLEI), modified from the original the Science Laboratory Environment Inventory (SLEI) (Fraser, Giddings, & McRobbie, 1993), and the Questionnaire on Teacher Interaction (QTI) (Wubbels & Levy, 1993) were used to collect data for the study. Modifications were made to the PLEI and the QTI to make them suitable for use in physics classes at the upper secondary school level in Thailand. A group of doctoral students who were studying at Curtin University of Technology assisted in the translation the questionnaires from the English version to the Thai version. The PLEI measures five dimensions of the physics laboratory environment, namely, Student Cohesiveness, Open-Endedness, Integration, Rule Clarity, and Material Environment. The QTI measures eight dimensions of students' perceptions of their teacher's interpersonal behaviour in the physics classroom, namely, Leadership, Understanding, Uncertain, Admonishing, Helping/Friendly, Student Responsibility/Freedom, Dissatisfied and Strict.

Each version of the questionnaires was field-tested using 11 classes of 383 students and five teachers from the Udonthani Rajabhat University. Interviews with teachers, in conjunction with observations of their students, assisted in determining the suitability of the questionnaires for the Thai context. Students also were interviewed during the validation process to check the accuracy of the translations and to ensure that their perceptions of individual items on the questionnaires were according to the intention.

The PLEI and the QTI were the primary data gathering tools. In order to provide a measure of the students' achievement, assessment of students' attitudes in physics laboratory classes was measured by adapting eight items from the *Attitude to This Class Scale* which was based on the *Test of Science-Related Attitudes* (TOSRA) (Fraser, 1981). This adaptation involved using the word physics rather than science. Qualitative methods involved interviews with students. A distinctive feature of this study was that the quantitative information from questionnaires assessing students' opinions of physics classroom psychosocial environment was complemented by quantitative information from interviews. The sub-sample was intended to be about 5% (200 students) of a sample of 4,576 of physics students in upper secondary school classes for interviews.

1.9 OVERVIEW OF THE THESIS

Chapter 1 has described how and why the objectives of this study were formulated, has provided background information to set the context of the study and gave a brief overview of the methodology. Following this introductory chapter there are six additional chapters in this thesis.

Chapter 2 contains a review of the literature in the field of classroom environment research, including theoretical aspects, a historical account and current trends in classroom environment research. Chapter 3 discusses the instruments used in the study, namely; the Questionnaire on Teacher Interaction; the Physics Laboratory Environment Inventory and the Attitude scale. Chapter 4 describes the research methodology adapted for the research. Chapter 5 presents the validation and reliability results of the translated versions of the elementary version of the QTI, the PLEI, the Attitudes Scale. Chapter 6 discusses the quantitative results differences in the actual and preferred learning environments and investigates the associations between students' perceptions of their actual and preferred of their teachers' interpersonal behaviour and physics laboratory classroom environments and their attitudes towards physics. Chapter 7 describes students' opinions based on the interviews and finally, Chapter 8 discusses the conclusions of significance and implications of the study and suggests recommendations for future classroom environment research in Thailand.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

To place this study in context, the first part of this review describes a history of education in Thailand and recent developments that affect the teaching of physics. Education in Thailand can be said to have begun in the 13th century when Sukhothai was Thailand's capital (the Sukhothai Period, A.D. 1238-1378). In 1283, one of Sukhothai's kings, Ramhamkaeng the Great, created the first Thai alphabet, using as its basis the Mon and Khmer scripts which had, in turn, been derived from a South Indian script. He employed for the first time the new alphabet in his stone inscription of 1292 at Sukhothai. During the Ayuttha Period (A.D. 1350-1767), the basic structure of education for the princes, boys of noble birth, and commoners was adopted by the court and people of Ayutthaya and still prevailed in the early reigns of the Bangkok period. It is worth mentioning that during the reign of King Narai the Great, a book for the study of the Thai language entitled *Chindamani* was written and became a popular text book in due time. It continued to be in use up to H.M. King Chulalongkorn's reign (1868-1910) and accepted as the first book of his learning. The Bangkok period (1782 onwards), was founded in 1728 by the King Rama I, the first King of the present Chakri Dynastic. He made an impact on the development of public education by reforming the Buddhist Church. King Rama V set up an *English school* in the palace to prepare prince and court children for further studies abroad as well as a number of schools outside the palace for the education of commoners' children.

The Department of Education became a fully fledged Ministry of Education in 1892 and, in 1898, the first *Education Plan* was launched. In 1902 the *National System of Education in Siam (Thailand)* retained all the education levels of the 1898 Plan. In 1913, the *School of Art and Crafts* (Poh Chang) was set up in Bangkok and in 1916, higher education emerged in Thailand as *Chulalongkorn University*. The *Compulsory Primary Education Act* was proclaimed in 1921 and primary schooling was extended to seven years. Then in 1977, Thailand's educational system was changed from a 4-

3-3-2 structure to a 6-3-3 system wherein six years of compulsory primary education was followed by three years at lower secondary school and then three years of upper secondary school. This is the structure in use today.

The aim of this chapter was to review related literature on classroom learning environment in fifteen main focus areas. First, it begins with some historical background by drawing upon the theoretical underpinning of research involving the assessment of classroom learning environments. In the second section, forms of instruments for assessing the classroom environment are described. The third section presents the validation of questionnaires designed to measure the learning environment. Research on learning environments in Asian countries and other countries, including actual and preferred differences in student perceptions, are then reviewed, and investigations on practical attempts to improve classroom learning environment are considered. The following sections explain comparisons between actual and preferred forms of learning environment instruments and associations between students' perceptions of their learning environments and their attitudinal outcomes.

2.2 HISTORICAL BACKGROUND OF LEARNING ENVIRONMENT RESEARCH

2.2.1 Approaches to Studying Educational Environments

Educational classroom environment research is built on the theoretical frameworks from three areas of earlier work. Firstly, the work of Lewin (1936) and Murray (1938) were conceptualizations of the assessment of learning environments. Lewin (1938) devised the formula $B = f(P,E)$ to describe human behaviour (B) as a function of two interdependent influences, the Person (P) and the Environment (E). Murray developed this theory to describe the concept of the personal needs of an individual (including goals and drives) as distinct from the environment press (including stimulus, treatment and process variables). Murray's needs-press theory led to the development of various measures of personality which were elucidated by Pace and Stern (1958). Many of the instruments that have been used in the study of learning environments are related to the theoretical frameworks for human environments proposed independently by Moos (1968) (section 2.2.1) and Walberg (1968).

Murray (1938) discussed these two ways of describing the environment and defined them by using the concept of *alpha* and *beta* presses. The *alpha* press is the concept of an outside observer describing the environment whilst the *beta* press is the perceptions of those within the environment. The work of both Moos (1968) and Walberg (1968) was also significant because it used the concept of Murray's (1938) beta press and involved the perceptions of teachers and students within the classroom environment rather than the perceptions of external objective researchers.

Moos (1973) classified three broad dimensions of human social environments. These are *Relationship Dimensions* (which identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support one another), *Personal Development Dimensions* (which assess basic directions along which personal growth and self-enhancement tend to occur) and *System Maintenance and System Change Dimensions* (which involve the extent to which the environment is orderly, clear in expectation, maintains control and is responsive to change).

Walberg began his pioneering efforts in the use of classroom environment assessments over 30 years ago during the quest for a better way to evaluate curriculum innovations whilst working on the Harvard Project Physics (Anderson & Walberg, 1968). Walberg's theory of educational productivity (Walberg, 1981, 1984) states that there are nine factors which contribute to variance in students' cognitive and affective outcomes. These factors are: student ability, age and motivation; the quality and quantity of instruction; and the psychosocial climate of the home, the classroom social group, the peer group outside the classroom, and the mass media. Walberg's model was tested by using data collected as part of national studies. These studies confirmed its validity in showing that student achievement and attitudes are influenced by a range of factors rather than by just one dominant factor (Walberg, 1968; Walberg, Fraser, & Welch, 1986). Classroom and school environment factors were found to be particularly important influences on students' outcomes. Similarly, Getzels and Thelen (1960) proposed a model of the school class as a social system and suggested that group behaviour can be predicted from personality needs, role expectations and classroom environment.

The environmental forces which impact on individuals can be described in two ways, either by individuals within the environment or by observers outside the environment.

Fisher and Fraser (1992) defined the classroom environment in terms of the shared perceptions of the students, and sometimes the teachers, of that environment. This definition has two advantages. First, it characterizes the setting through the eyes of the actual participants and second, it captures data that an observer could miss or consider unimportant. Students are in a good position to make judgments about their classrooms because not only do they experience many different learning environments but they spend sufficient time in class to form accurate impressions (Fraser, 1994).

2.2.2 The Assessment of the Classroom Environment

This section considers an important aspect found in the literature and that is the assessment of classroom learning environment using questionnaires. Examples of some of these questionnaires are discussed in the following section.

2.2.2.1 The Development of the LEI and the CES

The current use of quantitative assessment measures of classroom learning environments dates from the late 1960s and early 1970s. Moos studied the environments of psychiatric hospitals (Moos & Houts, 1968), correctional institutions (Moos, 1968) and classrooms. For the latter, he developed the *Classroom Environment Scale* (CES) (Moos & Trickett, 1974). About the same time, Walberg developed the *Learning Environment Inventory* (LEI) (Anderson & Walberg, 1968; Fraser, Anderson, & Walberg, 1982; Walberg, 1968) as part of an evaluation of the Harvard Project Physics. These two instruments remain in use and have been the basis for the development of many similar instruments.

In order to provide a comprehensive cover of the three dimensions referred to on page 16, Moos developed the CES as a questionnaire containing nine scales, each represented by 10 items. Students responded to a True/False format. The LEI, as already mentioned, reflected a similar conceptualization of the classroom environment to that of the CES. The final version of the LEI contained 15 scales, each represented by 7 items to which students and teachers respond by using a four point Likert type scale with response categories of 'Strongly Disagree, Disagree, Agree, Strongly Agree'. As with the CES, this instrument also underwent trials and statistical analysis to ensure reliability and discriminant validity. These descriptive statistical details are reported extensively in Fraser, Anderson and Walberg (1982). The independent contributions of Moos and Walberg in the development of the CES and the LEI, respectively, have pioneered much of the subsequent quantitative research into classroom learning environment.

2.2.2.2 Development of Other Instruments for Assessing the Classroom Environment

Following the development of the CES and the LEI there have been many other instruments developed and some of these are briefly reviewed below in chronological order of their development. They shared a common conceptualization of the classroom environment as a dynamic social system but each focuses on aspects of the environment that are perceived by the developers to be important to their research investigations. Each of the instruments has been trialed extensively and statistically analyzed and refined so that researchers can be confident of the reliability and discriminant validity of the instruments. This aspect of the development of each instrument is not reviewed here but is extensively covered in the references given for each of the instruments.

The five criteria for developing these instruments can be summarized as: information from relevant literature: dimensions included should characterize important aspects in the classroom environment, such as, relationships among students and between teachers and students and the organizational structure (e.g., order and organization); coverage of Moos's three general categories of dimensions, namely, relationship, personal development, and system change dimensions; scales and individual items should cover aspects of the classroom environment perceived to be salient by teachers; only material which is specifically relevant to the classroom should be included and finally, achieve economy by developing an instrument with a relatively small number of reliable scales, each containing a fairly small number of items.

The Individualized Classroom Environment Questionnaire (ICEQ)

The ICEQ (Fraser, 1990; Rentoul & Fraser, 1980) is used to assess the extent to which a classroom environment is characterized by the perception that the curriculum is individualized for students. It includes dimensions of Personalization, Participation, Investigation and Differentiation which are considered to be important variables in an individualized curriculum.

The My Class Inventory (MCI)

This instrument is a simplified version of the LEI and is intended for use in primary classrooms. Consequently, it is shorter than the LEI, the language is simpler, and the items only require Yes/No responses (Fisher & Fraser, 1981; Fraser, Anderson, & Walberg, 1982; Fraser & O'Brien, 1995).

The College and University Classroom Environment Inventory (CUCEI)

Like the MCI this inventory was developed for a particular age cohort of students. It has been developed specifically to investigate the learning environment of university and college classes of up to 30 tertiary students (Fraser & Treagust, 1986; Fraser, Treagust, & Dennis, 1986). It contains dimensions adapted from previous instruments, including the ICEQ which reflect the greater degree of individualized work expected in tertiary classrooms. It is not intended for laboratory work.

The Constructivist Learning Environment Survey (CLES)

This instrument (Taylor, Dawson, & Fraser, 1995; Taylor & Fraser, 1991; Taylor, Fraser, & Fisher, 1997; Taylor, Fraser, & White, 1994) reflects the epistemological changes inherent in constructivist methodology and was developed to allow teachers and researchers to examine classrooms from a constructivist perspective. This is clearly seen in dimensions such as Critical Voice and Student Negotiation.

The What Is Happening In this Class? (WIHIC) Questionnaire

The WIHIC questionnaire is a more recent addition to these learning environment questionnaires. It combines modified versions of the most salient scales from a wide range of existing questionnaires together with additional scales designed to accommodate contemporary educational concerns (Fraser, Fisher, & McRobbie, 1996). Only 56 items in seven scales survived these procedures, this led to a final form of the WIHIC containing seven eight-item scales.

The Questionnaire on Teacher Interaction (QTI)

The QTI (Wubbels & Brekelmans, 1997; Wubbels & Levy, 1993) was developed to assess student perceptions of eight scales of aspects of teachers' interpersonal behaviour. The QTI focuses on the nature and quality of interpersonal relationships between teachers and students. This questionnaire is discussed in more detail in Chapter 3.

The Science Laboratory Environment Inventory (SLEI)

Laboratory settings are different from classroom settings and teachers expect different relationships between students who are usually engaged in tasks which differ from those in regular classrooms. The SLEI (Fraser, Giddings & McRobbie, 1995) was developed to allow investigation of this unique environment The SLEI is discussed in more detail in Chapter 3.

Table 2.1
Summary of Some Classroom Environment Instruments

Instrument	Level	Scale Classified According to Moos's Scheme			
		Items per scale	Relationship Dimensions	Personal Development Dimensions	System Maintenance And Change Dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favoritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material-Environment Goal Direction Disorganization Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order & Organization Rule Clarity Teacher Control Innovation
Individualized Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalization Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Primary	6-9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalization Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualization
Science Laboratory Environment Inventory (SLEI)	Upper Secondary/ Higher Ed.	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Questionnaire on Teacher Interaction (QTI)	Secondary/ Primary	8-10	Helpful/friendly Understanding Dissatisfied Admonishing		Leadership Student Responsibility/ Freedom Uncertain Strict
Constructivist Learning Environment Survey(CLES)	Secondary	7	Personal Relevance Scientific Uncertainty	Critical voice Shared Control	Student Negotiation
What Is Happening In this Class? (WIHIC)	Secondary	8	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity

Adapted from Fraser (1998a, p. 10)

Table 2.1 shows the instruments reviewed in chronological order. It is easy to see the major changes in educational philosophy and practice evident in the scales which have been chosen for the instrument. These instruments span over 30 years research and each focuses on different aspects of classroom environments. Modifications of these instruments are constantly being made, not only in Australia, but in many other countries, to produce other versions of these instruments to meet particular needs, for example, the 40-item *Cultural Learning Environment Questionnaire* (CLEQ) (Fisher & Waldrip, 1997).

Table 2.1 shows the name of each scale contained in each instrument, the level (primary, secondary, and higher education) for which each instrument is suited, the number of items contained in each scale, and the classification of each scale according to Moos's (1973) scheme for classifying human environments. Each of the instruments described in Table 2.1 has been field tested extensively and found to be valid and reliable for applications involving either the individual student's score or the class mean score as the unit of analysis (Fraser, 1998a).

2.3 VALIDATION OF CLASSROOM ENVIRONMENT INSTRUMENT SCALES

Table 2.2 provides a summary of a limited amount of statistical in formation for the nine instruments and information about each scale's internal consistency reliability (alpha coefficient), discriminant validity (using the mean correlation of a scale with the other scales in the same instrument as a convenient index) and the ability of a scale to differentiate between the perceptions of students in different classrooms (significance level and eta^2 statistic from ANOVAs). Statistics are based on 1,048 students for the LEI (Fraser, Anderson, & Walberg, 1982); 1,083 students for the CES (Fisher & Fraser, 1983); 1,849 students for the ICEQ (Fraser, 1991); 2,305 students for the MCI (Fisher & Fraser, 1981); 372 students for the CUCEI (Fraser & Treagust, 1986); 3,994 high school science and mathematics students for the QTI (Fisher, Fraser, & Rickards, 1996); 3,727 senior high school students for the SLEI (Fraser, Giddings, & McRobbie, 1995) and 1,081 high school science students for both the CLES and the WIHIC (Aldridge, Fraser, & Huang, 1999).

Table 2.2

Internal Consistency (Alpha Reliability), Discriminant Validity (Mean Correlation of a Scale with Other Scales), and ANOVA Results for Class Membership Differences (eta² statistic and significance level) for Student Actual From of Nine Instruments Using Individual as Unit of Analysis

Scale	Alpha Rel.	Mean Correl With Other scales	ANOVA Results *(eta²)*
Learning Environment Inventory (LEI)			
Cohesiveness	0.69	0.14	-a
Diversity	0.54	0.16	-
Formality	0.76	0.18	-
Speed	0.70	0.17	-
Material Environment	0.56	0.24	-
Friction	0.72	0.36	-
Goal Direction	0.85	0.37	-
Favouritism	0.78	0.32	-
Difficulty	0.64	0.16	-
Apathy	0.82	0.39	-
Democracy	0.67	0.34	-
Cliqueness	0.65	0.33	-
Satisfaction	0.79	0.39	-
Disorganization	0.82	0.40	-
Competitiveness	0.78	0.08	-
Classroom Environment Scale (CES)			
Involvement	0.70	0.40	0.29*
Affiliation	0.60	0.24	0.21*
Teacher Support	0.72	0.29	0.34*
Task Orientation	0.58	0.23	0.25*
Competition	0.51	0.09	0.18*
Order and Organization	0.75	0.29	0.43*
Rule Clarity	0.63	0.29	0.21*
Teacher Control	0.60	0.16	0.27*
Innovation	0.52	0.19	0.26*
Individualized Classroom Environment Questionnaire (ICEQ)			
Personalisation	0.79	0.28	0.31*
Participation	0.79	0.27	0.21*
Independence	0.68	0.07	0.30*
Investigation	0.71	0.21	0.20*
Differentiation	0.76	0.10	0.43*
My Class Inventory (MCI)			
Cohesiveness	0.67	0.20	0.21*
Friction	0.67	0.26	0.31*
Difficulty	0.62	0.14	0.18*
Satisfaction	0.78	0.23	0.30*
Competitiveness	0.71	0.10	0.19*

Scale	Alpha Rel.	Mean Correl With Other scales	ANOVA Results *(eta²)*
College and University Classroom Environment Inventory (CUCEI)			
Personalization	0.75	0.46	0.35*
Involvement	0.70	0.47	0.40*
Student Cohesiveness	0.90	0.45	0.47*
Satisfaction	0.88	0.45	0.32*
Task Orientation	0.75	0.38	0.43*
Innovation	0.81	0.46	0.41*
Individualisation	0.78	0.34	0.46*
Questionnaire on Teacher Interaction (QTI)			
Leadership	0.82	-b	0.33*
Helping/Friendly	0.88	-	0.35*
Understanding	0.85	-	0.32*
Student Respon-sibility/Freedom	0.66	-	0.26*
Uncertain	0.72	-	0.22*
Dissatisfied	0.80	-	0.23*
Admonishing	0.76	-	0.31*
Strict	0.63	-	0.23*
Science Laboratory Environment Inventory (SLEI)			
Student Cohesiveness	0.77	0.34	0.21*
Open-Endedness	0.70	0.07	0.19*
Integration	0.83	0.37	0.23*
Rule Clarity	0.75	0.33	0.21*
Material Environment	0.75	0.37	0.21*
Constructivist Learning Environment Survey (CLES)			
Personal Cohesiveness	0.88	0.43	0.16*
Uncertainty	0.76	0.44	0.14*
Critical View	0.85	0.31	0.14*
Shared Control	0.91	0.41	0.17*
Student negotiation	0.89	0.40	0.14*
What Is Happening In This Classroom (WIHIC)			
Student Cohesiveness	0.81	0.37	0.09*
Teacher Support	0.88	0.43	0.15*
Involvement	0.84	0.45	0.10*
Investigation	0.88	0.41	0.15*
Task Orientation	0.88	0.42	0.15*
Cooperation	0.89	0.45	0.12*
Equity	0.93	0.46	0.13*

[a] *This statistic is not available for the LEI*

[b] *This statistic is not available for the QTI*

Adapted from Fraser (1998a, p. 18-19)

What is important in Table 2.2 is that it provides a clear direction as to what statistics should be employed in this study. Two particular instruments, the Questionnaire on Teacher Interaction (QTI) and the Science Laboratory Environment Inventory (SLEI) could be particularly useful for describing students' perception of physics classroom environments in upper secondary school classes in Thailand.

2.4 FORMS OF INSTRUMENTS FOR ASSESSING THE CLASSROOM ENVIRONMENT

2.4.1 Actual and Preferred Forms

A distinctive feature of most of the instruments in Table 2.1 (see page 22) is that, in addition to a form that measures the students' perceptions of their *actual* classroom environment, there is another form that measures the students' *preferred* classroom environment. The preferred forms measure the students' perceptions of the classroom learning environment that they would ideally like or prefer. Although the wording of items is similar for actual and preferred forms, different instructions for answering each are used. For example, *'I work cooperatively in laboratory sessions'* in the actual form is changed to *'I would work cooperatively in laboratory sessions'* in the preferred form.

2.4.2 Personal and Class Forms

Fraser and Tobin (1991) point out that there is potentially a major problem with nearly all existing classroom environment instruments when they are used to identify differences between subgroups within a classroom (e.g., males or females) or in the construction of case studies of individual students. The problem is that items are worded in such a way that they ask for an individual student's perception of the class as a whole, as distinct from a student's perception of his/her own role within the classroom. Personal forms of instruments were devised by rewording items of the Class Form. For example, items in the traditional class form might seek students' perceptions about whether '*the work of the class is difficult*'. In contrast, a personal form of the same item would ask for the student's individual or personal perception of how it affects them and would be worded as '*I find the work of the class difficult.*'

In response to this, McRobbie, Fraser, and Giddings (1991) developed and validated parallel Class and Personal forms of both actual and preferred versions of the Science Laboratory Environment Inventory (SLEI). They showed that students' scores on the Class Form were found to be systematically more favourable than their scores on the Personal Form, perhaps suggesting that students have a more detached view of the environment as it applies to the class as a whole. An investigation of gender differences in student perceptions of science laboratory classes suggested that gender differences in perceptions were somewhat larger on the Personal Form than on the Class Form.

Associations between student outcomes and their perceptions of the science laboratory environment revealed that the associations were comparable for class and personal forms of the SLEI. These three results showed the importance of having both class and personal forms of learning environment questionnaires. While traditional class forms of instruments have elicited an individual student's judgments of the class as a whole, research by McRobbie, Fisher and Wong (1998) using the SLEI showed that personal and class forms of this instrument accounted for unique variance in attitudinal outcomes of students that could not be explained by the other form. That is, class and personal forms seem to assess different components of classroom environment.

2.4.3 Short Forms

Although the long forms of classroom environment instruments have been used successfully for a variety of purposes, some researchers and teachers reported that they would like instruments to take less time to administer and score. The development of the short form of instruments was based largely on the results of several item analyses performed on data obtained by administering the long forms of each instrument to a large sample. Therefore, short forms of questionnaires were developed, for example the MCI, ICEQ and CES (Fraser & Fisher, 1986).

2.5 RESEARCH IN ASIAN COUNTRIES

Because the research described in this thesis was conducted in Thailand, it was considered essential to review research that focused on using classroom environment instruments in Asia. Lin and Crawley (1987) investigated differences in classroom learning environment and science-related attitudes with 1,269 Taiwanese junior high school science students. Using the LEI, it was found that urban science classes, when compared to students in rural science classes, were characterized by more speed, friction, favoritism, difficulty, cliqueness, and competitiveness. No differences were found when students were grouped according to sex or ability. It was found that differences existed in students' attitudes to science and that these differences depended on the school's location, sex of students and student ability.

In Brunei, Khine and Fisher (2001) used the WIHIC to investigate associations between students' perceptions of science classroom learning environment, their attitudinal outcomes and the cultural backgrounds of their teachers. A sample of 1,188 students from 54 science classes in ten secondary schools responded to two scales of the Test of Science Related Attitudes (TOSRA) that were used as attitudinal measures. The study also found that students in classrooms of Western teachers enjoyed their science lessons more than those students in the other classes.

Also in Brunei, Majeed, Fraser, and Aldridge (2001) reported a study of lower secondary mathematics classroom environments. A sample of 1,565 students from 81 classes in 15 government secondary schools was assessed with a version of the MCI. This study revealed satisfactory reliability and validity for a refined three-scale version of the MCI assessing cohesiveness, difficulty and competition.

Scott and Fisher (2001) used an elementary version of the QTI and a scale for determining students' enjoyment of their science lessons in Brunei. The questionnaire was translated into standard Malay. The instruments were validated with a sample of 3,104 students in 136 classrooms in 23 typical, co-educational government primary schools. The students perceived their teachers mostly as good leaders, helping/friendly, understanding and strict, seldom allowing student responsibility and freedom, seldom uncertain or dissatisfied and admonishing.

In Singapore, Goh and Fraser (1998) used the QTI and a modified version of the MCI to establish associations between student cognitive and affective outcomes and perceived patterns of teacher-student interaction in 39 primary school mathematics classes. In particular, higher cognitive outcomes were associated with better classroom teacher leadership, more helping/friendly classroom environments, and student linking and interest in mathematics was related positively with improved levels of student cohesion and reduced levels of classroom friction. Quek, Wong and Fraser (2002) investigated differences in boys' and girls' perceptions of their chemistry laboratory classroom environment using the Chemistry Laboratory Environment Inventory (CLEI). The CLEI has five scales for assessing Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment. The sample comprised 312 boys and 185 girls in 18 secondary 4 (year 10) chemistry classes from 3 independent schools in Singapore. Overall, the CLEI was found to be a reliable and valid instrument for use in the Singapore context. When students' responses to actual and preferred versions of the CLEI were compared, statistically significant differences were found between the boys' and girls' perceptions of their chemistry laboratory classroom environment. This study showed that girls perceived their learning environment more favourably than did boys. These differences in perceptions are presented and some implications for chemistry laboratory teaching are discussed.

In Indonesia, Margianti, Fraser, and Aldridge (2001) reported the findings of a study on the influence of the classroom learning environment on students' cognitive and affective outcomes among 2,498 third-semester computer students in 50 university-level classes. Students' perceptions, and males' and females' perceptions of the actual and preferred classroom learning environment in linear algebra and statistics, were measured using an Indonesian version of the WIHIC questionnaire.

In Korea, Lee and Fraser (2001) reported an investigation of Korean high schools by using the SLEI with 439 high school students in science laboratory classrooms. Interviews with students confirmed their responses to items of the SLEI and provided additional information about laboratory classroom environments in Korea. Lee and Taylor (2001) studied learning environments using the CLES in a Korean context. They concluded that it was desirable to modify questionnaires making them sensitive to the local cultural context in order that respondents can represent meaningfully their own experiences.

In India, Walberg, Singh and Rasher (1977) administered the LEI, translated into Hindi, to a random sample of 3,000 grade 10 students in 83 science classes in 26 districts of the state of Rajasthan. Simple correlations between students' cognitive outcomes and LEI scales ranged from 0.41 to 0.70 in science.

Koul and Fisher (2002) carried out an in-depth study of teacher-student interactions and science classroom learning environments in Jammu, India. The QTI, the WIHIC and an Attitude Scale were administered to 1,021 students from 32 science classes in seven different co-educational private schools in Jammu. Students were interviewed to determine further the reliability of the questionnaires. An educational critique was used to describe the social and cultural factors that could influence the prevailing learning environments. Positive associations were found between students attitude toward science and the WIHIC scales, for example when students perceived increased levels of investigation, task orientation and helping/friendly teacher behaviour in the classroom environment they had a better attitude to their class.

In Thailand, Fraser (1984) provided cross-cultural data about the predictive validity of students' perceptions. The sample consisted of 989 grade 12 physics students in 31 classes in Bangkok and nearby provinces, where a Thai version of the LEI was used to predict three attitudinal outcomes. More favourable attitudes to physics learning were expressed in classes perceived as having more cohesiveness, less friction, less cliqueness, and more satisfaction, while greater enjoyment of physics was reported in classrooms characterized as having less speed, less disorganization, and greater competitiveness.

2.6 RESEARCH IN OTHER COUNTRIES

As indicated earlier in this chapter, most classroom environment research of the past 30 years has been conducted in the USA and Australia. While this research has continued, the field of classroom environment research has become more international as indicated at the 2002 and 2003 Australian Educational Research

Association annual meetings including papers on research from China (Song & Hunt, 2002), Hong Kong (Thomas, 2002), Canada (Nair & Fisher (2001); Raaflaub & Fraser, 2002; Zandvliet, 2003), Brunei (Khine & Fisher, 2001) and Nigeria (Idiris & Fraser, 1997). Such studies have included cross-national investigations that enhance the generalizability of findings and the importance of learning environment studies.

Others studies have been conducted in Fiji, Baba and Fraser (1983) used student perceptions of several aspects of classroom psychosocial environment in evaluating a social science curriculum. A locally developed instrument was used to assess interest, ease, and adequacy of time among a sample of 834 seventh grade students in 30 classes of six schools on Viti Levu, the main island of Fiji. The finding that the mean score was relatively high for most questionnaire items provided summative evaluative information suggesting that the majority of activities in the curriculum were perceived by students as interesting and allowed sufficient time for completion.

Furthermore in South Africa, Ntuli (2001) reported on evaluating and improving teaching practice and distance teacher training programs using learning environment instruments. The WIHIC was administered in primary school mathematics classes. Based on the results, students were more satisfied with their class after the implementation of the new curriculum and discrepancies between students' actual and preferred perceptions were reduced.

In another South African study, Sebela (2001) used the CLES in a teacher action research study to promote classroom learning environments in mathematics. A sample of 18 teachers with 36 classes and around 1,700 students was used. The findings had the potential to guide curriculum advisers in the organization and running of in-service training courses, and encouraged teachers and provided them with the skills to be reflective practitioners and researchers within their own classrooms.

2.7 COMPARISONS BETWEEN ACTUAL AND PREFERRED FORMS OF LEARNING ENVIRONMENT QUESTIONNAIRES

This section considers prior research that focused on investigations of differences between students' perceptions of their actual and preferred learning environment in the same classrooms and investigations of whether students achieve better in their preferred environments.

Fraser, Giddings and McRobbie (1992) used the SLEI with 1,875 senior high school students and 298 university students in Australia. Both the actual and preferred forms were administered to these samples. Typically, the students indicated that they preferred a more positive laboratory learning environment than that which they actually perceived to be present.

Quek, Fraser and Wong (2001) used the Chemistry Laboratory Environment Inventory (CLEI) and the Questionnaire on Teacher Interaction (QTI) in Singapore. Their study confirmed the reliability and validity of the actual and preferred versions of the questionnaires and statistically significant differences were found between the students' perceptions of their actual and preferred chemistry laboratory classrooms and their chemistry teachers' interpersonal behaviour.

An investigation of differences between students and teachers in their perceptions of the same actual classroom environment and of differences between the actual environment and that preferred by students or teachers was reported by Fisher and Fraser (1983) using the ICEQ with a sample of 116 classes for the comparisons of student actual with the student preferred scores and a subsample of 56 of the teachers of these classes for contrasting teachers' and students' scores in Tasmania. Students preferred a more positive classroom environment than was actually present for all five ICEQ dimensions. Also, teachers perceived a more positive classroom environment than did their students in the same classrooms on four of the ICEQ's dimensions.

Similarly, Rickards and Fisher (1999) used a sample of 153 teachers and their 3,515 students from 164 secondary school science classes in 35 schools all of whom completed the QTI. Generally, teachers perceived their interactions more positively than did their students. The paper also describes how science teachers can and have used the questionnaire to assess perceptions of their own teacher-student interactions and used this as a basis for reflecting on their own teaching practice.

In another study, Fisher, Rickards and Newby (2001) compared students' perceptions of teacher-student interactions with those of their teachers by administering the Questionnaire on Teacher Interaction (QTI) to teachers and students in 80 lower secondary classes in schools in Tasmania and Western Australia. Students completed the student version of the QTI, which assesses the students' perceptions of the teacher-student interactions in a specific class, while their teachers completed the teacher actual version, indicating how they perceived their interactions with their students in those same classes. The teachers also indicated how they thought ideal teachers would interact with students by responding to the teacher ideal version. Two multilevel models were proposed: the teacher ideal interaction influences the teacher actual interaction; and the teacher actual affects the student actual and vice versa. Using structural equation modeling techniques, both models were found to be reasonable fits to the data. The results would seem to confirm the underlying basis of the QTI in that the teachers' actual perceptions of their interactions with students affects the students' perceptions, which in turn affect the teachers' perceptions.

Overall, the findings suggested that actual-preferred congruence (or person-environment fit) could be an important variable in predicting student achievement of affective and cognitive aims. The practical implication is that class achievement of certain outcomes might be enhanced by changing the actual classroom environment in ways which makes it more congruent with that preferred by the class. However, Fraser (1991) cautioned that these findings could not be used as a basis for moving an individual student to a classroom that matched his/her preferences in order to obtain individual better results, but rather for improving certain outcomes by changing the actual classroom environment to make it more congruent with the preferred environment of the class. This is relevant to the present research which is a practical application of actual and preferred versions of questionnaires to investigate classroom learning environment.

The feedback information based on student perceptions of actual and preferred environments, can be employed as a basis for reflection. The proposed procedure incorporated the following five steps (Fraser & Fisher, 1986).

Step 1: The classroom environment instruments are administered to all students in the class. The preferred form is answered first and the actual form is administered in the same lesson. This step is named *Assessment*.

Step 2: The teacher is provided with feedback information derived from student responses and representing the class means of students' actual and preferred environment scores. These profiles permit ready identification of the changes in classroom environment needed to reduce major differences between the nature of the actual environment as currently perceived by students and the preferred environment perceived by students. This step is named *Feedback.*

The teacher engages in private reflection and informal discussion about the profiles in order to provide a basis for a decision about whether an attempt will be made to change the environment in terms of some of the classroom environment instruments dimensions, e.g., the teacher should be more supportive and their should be greater organization in the class. This step is named *Reflection and Discussion.*

Step 4: The teacher introduces an intervention of approximately two months' duration in an attempt to change the classroom environment in each semester. This intervention consisted of a variety of strategies, such as to increase Order and Organization taking considerable care with distribution and collection of materials during activities and ensuring that students work more quietly. This step is named *Intervention.*

Step 5: The student actual form of the scales is readministered at the end of the intervention to see whether students are perceiving their actual classroom environments differently from before. This step is named *Reassessment.*

For example, Booth (2001) in an evaluation of a change in teaching methods in oral health science used actual and preferred versions of the CUCEI in a class of 30 final year dental students. The students entered their actual perceptions before and after the module. After an intervention period, there were improvements in the students' ratings of all scales over the test period.

2.8 ASSOCIATIONS BETWEEN CLASSROOM ENVIRONMENT AND STUDENTS' OUTCOMES

A number of classroom environment research studies has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of classroom learning environment. For example, studies by Fraser and McRobbie (1995), Fisher, Henderson and Fraser (1995), McRobbie and Fraser (1993), Teh and Fraser (1995), and Wong and Fraser (1996) revealed consistent associations between student outcomes and the nature of the classroom learning environment. Research studies and evaluations investigating associations between classroom learning environments and student attitudes are discussed in this section.

Wahyudi (2004) investigated students' attitudinal outcomes with an Indonesian version of the Test of Science-Related Attitude (TOSRA) (Fraser, 1981). No statistically significant differences were found on attitudinal outcomes between rural and urban and between male and female students' perceptions. However, the study identified that students' cognitive scores were statistically significantly different between rural and urban schools. Students in urban schools scored higher in the examination than did their counterparts in rural schools. Both simple and multiple regressions analyses procedures showed that all scales of the Indonesian WIHIC were associated with two scales of the Indonesian adapted TOSRA and students' cognitive scores.

Koul and Fisher (2002) used a large-scale study to investigate associations between science students' perceptions of their interactions with their teachers, the cultural background and the gender of the students and their attitudinal and cognitive achievement scores, in Jammu, India. A sample of 1,021 students from 31 year nine and year ten science classes in seven schools completed the QTI, an attitude scale, and the students' cognitive examination results were obtained. Generally, the dimensions of the QTI were found to be significantly associated with student attitude scores. In particular, leadership, helping friendly and understanding behaviours were positively associated with student attitudinal outcomes. In contrast, the more oppositional behaviours, such as dissatisfied, admonishing and uncertain behaviours were negatively associated with attitudinal outcomes. As for cognitive achievement, there were positive associations with cooperative teacher behaviour and negative associations with oppositional behaviours.

Lightburn (2002) used the CLES, SLEI, and the WIHIC to assess the classroom environment and student outcomes when students are engaged in activities that integrate science process skills and use of information technology tools. An analysis of gender differences in students' achievement, attitudes and perceptions of classroom environment revealed that boys had more positive attitude to science than did girls.

Zandvliet and Buker (2002) employed a version of the WIHIC and a *Computerized Classroom Environment Checklist* to evaluate Internet classrooms in British Columbia, Canada. Analyses of their classroom environment data revealed that student autonomy/independence and task orientation were associated with satisfaction in learning.

Reid and Skryabina (2002) reported a study of student attitudes toward physics where it was found that those students who had experienced an application-focused upper school physics course had more positive attitudes toward physics. Moreover, it was found that university students continued to seek this dimension in their studies. In addition the notion that positive attitudes toward physics need to be fostered early in secondary education was confirmed. Reid and Skryabina (2002) also noted that this Scottish Secondary Education physics course remains very popular.

Francois (2002) used a modified version the WIHIC and the TOSRA in both Australia and Indonesia with a sample of 1,161 students (594 students from 18 classes in Indonesia and 567 students from 18 classes in Australia). All the students came from private coeducational schools. The use of MANOVA revealed that there were a few differences between Australian and Indonesian students' perceptions of their classroom environments and in their attitudes to science. A comparison between male and female students in the two countries revealed that both genders had almost similar perceptions of their learning environments and attitudes to science. A series of simple correlation and multiple regression analyses revealed reasonably strong and positive associations between each classroom environment scale and the attitude scales. Overall Teacher Support and Involvement were the strongest independent predictors of student attitudes to science in both Indonesia and Australia.

Fisher and Stolarchuk (2001) evaluated of the effectiveness of laptop computers in grades 8 and 9 science classrooms in a sample of Australian independent Schools. Effectiveness was determined in terms of the impact laptop computers have had on laptop students' attitudinal and achievement outcomes and their perceptions of science classroom environment. Students' attitudes to science were assessed using a scale from the TOSRA instrument, achievement was measured using scales from the Test of Enquiry Skills (TOES) instrument, while students' perceptions of the science classroom environment were assessed using the *Science Classroom Environment Survey* (SCES). These quantitative instruments were administered to 433 laptop and 430 non-laptop students in 14 independent schools across four Australian states. The results indicated that those laptop science classrooms characterized by opportunities for individual students to interact with the teacher and with an emphasis on the skills and processes of inquiry best promoted positive student attitudes to science. However, laptop science classrooms characterized by selective treatment of students least promoted students' cognitive achievement in science.

Lee and Fraser (2001) investigated Korean high school students' perceptions about laboratory classrooms using the SLEI and the TOSRA. The sample consisted of 439 high school students from three different ability streams. When the perceptions of students from the three streams were compared, students from the science-independent stream perceived their classroom environments more favourably than did students in the other two streams.

Nair and Fisher (2001) used a validated and modified personalised form of the College and University Classroom Environment Inventory (CUCEI) at the senior secondary and tertiary levels of education, to compare both students' and instructors' actual and preferred perceptions of their classroom learning environments. Students at the tertiary level had a less favourable perception of the learning environment compared with senior secondary students and preferred a more positive environment in terms of the satisfaction with courses they were taking and the level of difficulty.

Soerjaningsih, Nusantara, Fraser, and Aldridge (2001) administered the QTI and the WIHIC to 422 students in 12 research methods classes at a private university in Indonesia, to measure students' perceptions of the learning environment and teacher interpersonal behaviour, and to assess students' affective outcomes. The data were analyzed to describe the learning environment and to examine associations between learning environment and students' cognitive and affective outcomes at the tertiary level of educational in Indonesia. The results indicated that understanding and helpful/friendly behaviours were positively associated with student achievement scores, while admonishing, dissatisfied and strict behaviours were negatively associated with students' achievement scores.

Churach and Fisher (1999) examined the extent and nature of Internet usage and its impact on the constructivist learning environment and students' attitudes towards science, with a sample of 431 students in five Hawaii Catholic high schools. The authors found that student attitudes, as well as individual feelings of self-control and personal relevance seemed to be enhanced by the use of the Internet.

Kim, Fisher, and Fraser (1999) used the CLES to investigate science curriculum reform efforts in Korea. Their data provided significant statistical relationships between classroom environments and students' attitudes. These results suggested that favourable student attitudes could be promoted in classes where students perceived more personal relevance, shared control with their teachers, and negotiated their learning.

Rawnsley and Fisher (1997) reported an investigation in the perceptions of 490 grade 9 mathematics students in 23 classrooms in 14 schools in Adelaide, South Australia, using the QTI. The study identified associations between students' perceptions of their mathematics classroom learning environment, their perceptions of their teacher's interpersonal behaviour, and student outcomes. Associations between students' perceptions of their mathematics classroom environment and attitudinal outcomes were stronger than the association with cognitive outcomes.

Fisher, Henderson and Fraser (1997) used the 35-item *Environmental Science Learning Environment Inventory* (ESLEI), an instrument containing scales derived from the SLEI, and the WIHIC. The sample was composed of Environmental Science students in five grade 11 and 12 classes. A total of 100 students in seven classes were involved, representing about one-third of the total population of Environmental Science students in Tasmania in 1996. Students studying another science subject were found to perceive some aspects of their Environmental Science classroom environment in a significantly more positive way than students not studying another science subject, and to have more positive attitudes. The study suggested that favourable students' attitudes could be promoted in science classes where the students perceive more cohesion amongst students.

Rickards & Fisher (1996) used the QTI in grades 8, 9 and 10 mathematics classes in Australia with 405 students in nine schools with their 21 teachers. Student attitudes were assessed with a seven-item Attitude to this Class scale, which was based on the TOSRA (Fraser, 1981). Generally, the dimensions of the QTI were found to be significantly associated with student attitude scores. In particular, students' attitude scores were higher in classrooms in which students' perceived greater leadership and helpful/friendly behaviours in their teachers' interpersonal behaviour.

Overall, classroom environment has been found to be a predictor of both achievement and attitudes even when a comprehensive set of other factors has been held constant. Studies such as these provide information to science educators and classroom teachers as a basis for guiding systematic attempts to enhance students' cognitive and affective outcomes.

2.9 CLASSROOM LEARNING ENVIRONMENT INSTRUMENTS SELECTED FOR USE IN THIS RESEARCH

Despite the fact that the classroom environment instruments were developed from Western perspectives, they have been found to be suitable for use in a variety of cultural setting including Asian countries (Chan & Watkins, 1994; Cheng, 1994; Fraser, Pearse, & Azmi, 1982; Wong & Fraser, 1995; Goh, Fraser, & Young, 1995; Khoo & Fraser, 1997; Koul & Fisher, 2002; Lang & Wong, 2001; Lee & Fraser, 2001; Lee & Tayler, 2001; Lin & Crawley, 1987; Schibeci, Rideng, & Fraser, 1987; Scott & Fisher, 2001; Teh & Fraser, 1995, 1997; Walberg, Singh, & Rasher, 1977). However, these instruments are yet to be used in Thailand in research studies. Therefore, it was considered appropriate and necessary to select and use appropriate convenient questionnaires to investigate the nature of physics classroom environments in Thailand.

2.10 SUMMARY OF THE CHAPTER

This chapter has reviewed research studies involving classroom environments, which began in earnest in the 1970s with the independent development of the CES and the LEI. Since then many instruments have been developed for the study of specific aspects of the classroom environment or for special age, sex or cultural environmental groups.

The different approaches which have been used to study classroom environments were examined along with a historical background of the development and use of classroom environment questionnaires. Many of these instruments have been developed in preferred and actual forms, in teacher and student forms, and, more recently, in personal and class forms. The use of different forms has enabled classes to be profiled from more than one perspective so that intervention strategies can be implemented to improve the classroom learning environments.

CHAPTER 3

QUESTIONNAIRES SELECTED IN THIS RESEARCH

3.1 INTRODUCTION

This chapter discusses the classroom learning environment instruments selected for use in this research. The rationale for the selection of the QTI as one of the classroom learning environment instruments in this study is followed by a discussion of the climate of physics laboratory classes including how laboratory teaching is one of unique features of education with in physics and therefore, the selection of the PLEI. Because students' perceptions of physics classroom environment have been favourably associated with student attitude to physics, it was decided to select an appropriate measure of students' attitudes. Students opinions' of physics laboratory classroom and experimental work was also a focus of this study.

3.2 THE QUESTIONNAIRE ON TEACHER INTERACTION (QTI)

One particular aspect of classroom environment is the relationship between the teacher and the student. Also, some teacher behaviour styles have been identified as being more favourable for promoting student outcomes than others. This section provides a background to the study of interactions between teachers and their students in the classroom, a model for teacher interpersonal behaviour, the development of the QTI, previous use of the QTI, assessment of teacher-student interpersonal relationships, and investigation of students' perceptions of physics teacher interpersonal behaviour in upper secondary school classes in Thailand.

3.2.1 Background on Interactions between Teachers and their Students

Interactions between teachers and their students go far beyond the classroom alone and extend to school camps, sports and other school community events. The personal interactions between the teacher and the students, as individuals and as a group, constitute a large part of what happens in the learning environment that a school provides. The social, historical and other antecedents that acted as major motivating factors of learning environments evolved over time at school as a part of these interactions. As Moos (1968), Moos and Houts (1968) report, mental hospitals, prisons and the armed services put people in comparable situations. There is also a great difference in the relative social power of the participants in teacher-student interaction and in the decision making process in classrooms as well as the privacy of students and teachers. A teacher is able to invade the privacy of a students' work or personal space at will. These factors have a role in defining the interactions and the learning environment, and it has been suggested that the nature of teacher-student interpersonal behaviour becomes skewed toward the teacher behaviour. This is a premise that supports the recording of perceptions of teacher behaviours as perceived by teacher and students in a classroom.

For the last three decades, researchers on learning environments have been involved in conceptualizing students' and teachers' perceptions of the teacher in terms of the interpersonal relationship between teachers and students (Fraser, 1986, 1998a; Wubbels & Brekelmans, 1998). Not only has this research shown that many teachers confirmed the problems that relate to teacher-student relationships in the classroom (Veenman, 1984; Wubbels, Brekelmans, & Hooymayers, 1993; Wubbels & Levy, 1993), it has also been demonstrated that students' perceptions of this relationship are strongly related to their educational outcomes, such as subject-related attitudes and cognitive achievement (den Brok, 2001; Levy, den Brok, Wubbels, & Brekelmans, 2004; Fraser, 1998; Henderson, Fisher, & Fraser, 2000; Wubbels & Levy, 1993).

3.2.2 The Leary Model for Interpersonal Behaviour

With this systems perspective in mind, Wubbels, Creton and Hooymayers (1985) developed a model to map teacher interpersonal behaviour using an adaptation of the work of Leary (1957). This model has been used in the development of an instrument, the QTI, to gather students' and teachers' perceptions of teacher interpersonal behaviour (Wubbels, Brekelmans, & Hooymayers, 1991; Wubbels & Levy, 1993). The Leary Model and the questionnaire development in the following sections.

Wubbels, Creton, and Holvast, (1988) investigated teacher behaviour in the classroom from a systems perspective which they called "the internal aspect of teacher behaviour" (Wubbels, Creton, & Hooymayers, 1985, p. 3) by adapting a theory on communication processes developed by Waltzlawick, Beavin, and Jackson (1967). The systems theory of communication suggested that "change in one part of the system leads to change in other parts of the system, which influence the first part, and so on" (Wubbels, Creton, & Holvast, 1988, p. 26). It is assumed that the behaviours of participants mutually influence each other. The behaviour of the teacher is influenced by the behaviour of the students and this in turn influences the students' behaviour. Wubbels, Creton, and Hooymayers (1993) referred to this as circularity and changed, and argue that "a circular communication process develops which not only consists of behaviour, but determines behaviour as well" (p. 2).

The Leary Model for interpersonal behaviour originated from research carried out by Leary and his colleagues, working on the Kaiser Foundation research project (Leary, 1957). It comprises two levels of behaviour; the dimensions of level one behaviour were classified in terms of interpersonal mechanics, gestures or reflexes and involved two-way interpersonal codes, whilst level two behaviours were classified in terms of interpersonal attributes or traits. Leary asserted that "every discernible or ratable interpersonal theme in the content of an individual's verbalizations defines a unit of level two behaviour".

This two-dimensional model based on the work of Leary (Wubbels, Creton, & Hooymayers, 1985) has been used widely in educational settings (Wubbels, Creton, Levy, & Hooymayers, 1993). Figure 3.1 shows the coordinate system of the Leary model which has been shown to be culturally universal for the types of human interaction measured (Wubbels & Levy, 1991), and Wubbels, Creton, Levy, and Hooymayers (1993) have added descriptors for the types of human interactions measured, namely, *Influence* and *Proximity* dimensions (see Figure 3.1). The Influence dimension indicates who is directing or controlling the communication. This is represented by the axis DS (for Dominance and Submission). The Proximity dimension indicates the degree of cooperation or closeness between those who are communicating and is represented by the axis CO (for Cooperation and Opposition).

According to Wubbels, Creton, Levy and Hooymayers (1993), the Leary Model allows all human interpersonal behaviour to be mapped graphically. Therefore, it is also possible to chart interpersonal teacher behaviour graphically. For example, a teacher who is explaining a concept patiently to students can be described as highly Dominant and Cooperative and can be represented by 'A' in Figure 3.1. On the other hand, because students are quiet and in agreement with the concept, the students' behaviour is described as highly Submissive and Cooperative and indicated as 'B' in figure 3.1. However, if the students decided to speak and disagreed with the concept, then the students' behaviour is described as increasingly Dominant, and Oppositional, and is represented as 'C' in Figure 3.1.

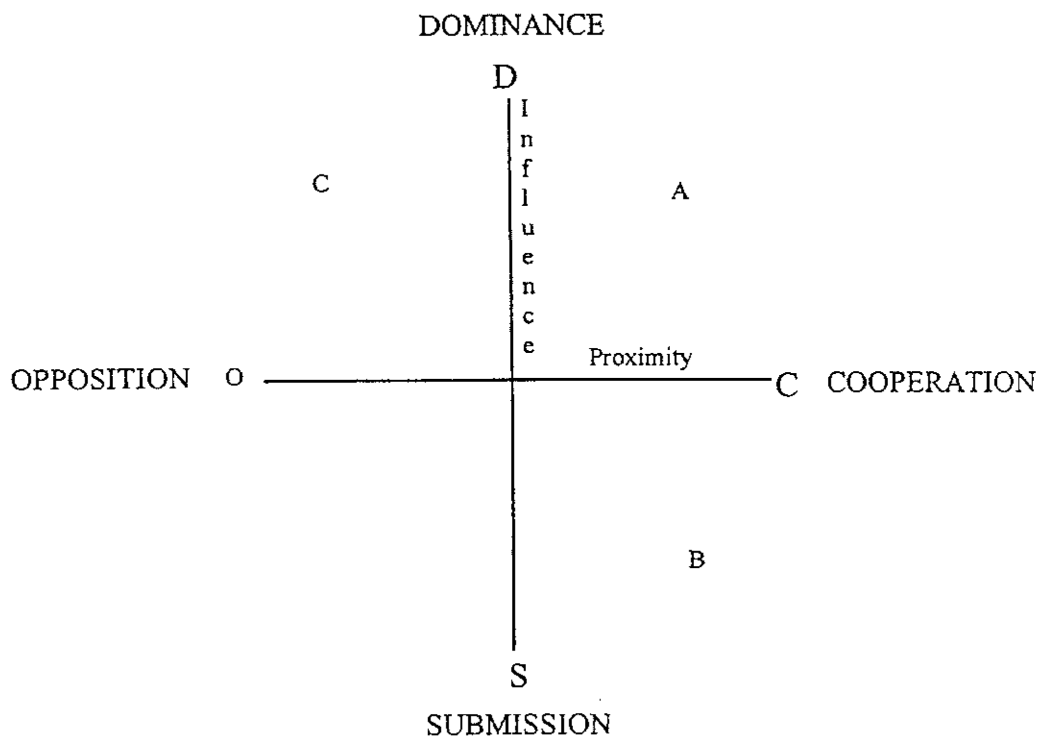


Figure 3.1. The coordinate system of the Leary model (Wubbels, 1993).

Based on the Leary Model, Wubbels, Creton, Levy and Hooymayers (1993) divided the Influence (DS) and Proximity (CO) dimensions into eight equal sectors in the form of an octagonal circumplex as shown in Figure 3.2. These eight sectors also represent the eight facets of interpersonal teacher behaviour, namely, *Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing* and *Strict* and labeled DC, CD, CS, SC, SO, OS, OD and DO according to their position in the octagonal circumplex (Figure 3.2).

Wubbels, Levy and Brekelmans (1997) subsequently applied the model to the classroom by dividing Leary's original two dimensions into the eight behavior types shown in Figure 3.2. The eight sectors are labeled DC, CD, and so forth, much like the directions on a compass. For example, sectors DC and CD are both characterized by dominance and cooperation. In the DC sector, however, the dominance aspect prevails over cooperation. Thus, a teacher displaying DC behavior might be explaining something to the class, organizing groups, or making assignments. The adjacent CD sector includes behaviors of a more cooperative, less dominant character, and the teacher might be assisting students or acting friendly or considerate.

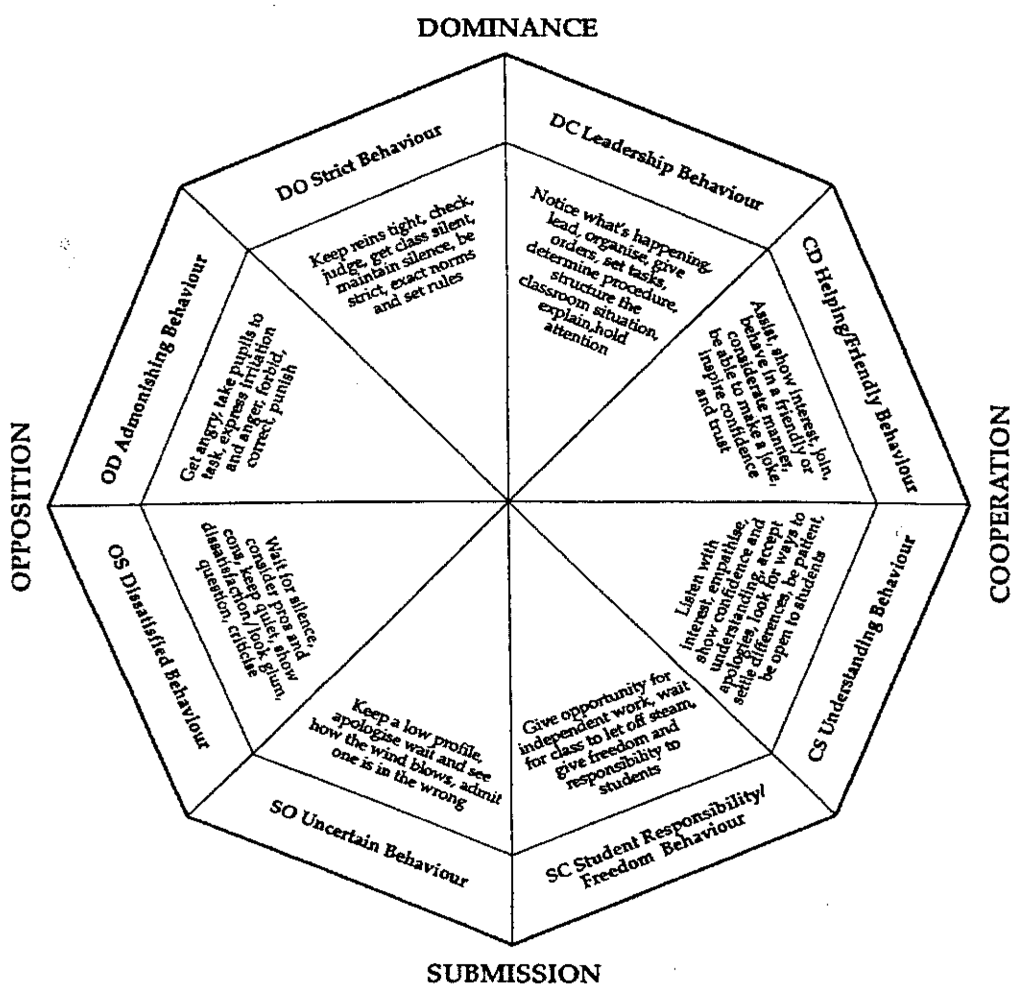


Figure 3.2. The model for teacher interpersonal behaviour (Wubbels & Levy, 1993, p. 36).

As can be seen in Figure 3.2, the sectors are labelled DC, CD, etc. according to their position in the circle. In the DC, or Leadership sector the Dominance aspect prevails over the Cooperation aspect, though both are characteristics of leadership. Each shaded area represents a measure of a particular behaviour. Table 3.1 (page 54) clarifies further the nature of the QTI by providing a scale description and for each of the eight scales.

3.2.3 The Development of the Questionnaire on Teacher Interaction

Wubbels, Creton, and Hooymayers (1985) designed a questionnaire to measure perceptions of teacher-student interpersonal behaviour, named the Questionnaire on Teacher Interaction (QTI). The QTI has been used in both research on teaching and learning environments as well as in teacher professional development (Levy, den Brok, Wubbels, & Brekelmans, 2004), to gather students' and teachers' perceptions of interpersonal teacher behaviour (Wubbels, Brekelmans, & Hooymayers, 1991; Wubbels & Levy, 1993). However, research with the QTI has shown that teacher-student communication patterns remain relatively stable within classrooms (Wubbels, Brekelmans, & Hooymayers, 1991; Wubbels & Levy, 1993).

The original version of the QTI in Dutch language consisted of 77 items and it was designed to measure secondary students' and teachers' perceptions of teacher-student interactions. After extensive analysis, the 77-item Dutch version was reduced to a 64-item version. The scales of the QTI are Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing and Strict behaviours. The other significant change was to modify the response format from a "yes" or "no" into a five point Likert-type response. The items were arranged into the eight scales corresponding to the eight sections of the model for teacher interpersonal behaviour. Later, an American version of the QTI was developed in the English language, which had 64 items (Wubbels & Levy, 1991). Items were deleted from the Dutch version following correlational analysis of the 77-item version to result in the 64 items used in the American version. The Australian version of the QTI has 48 items with 6 items in each scale (Fisher, Fraser, & Wubbels, 1993). Table 3.1 presents a description of each scale together with a sample item.

Table 3.1

Description and a Sample Item for Each Scale in the Questionnaire on Teacher Interaction (QTI)

Scale name	Description	Sample item
Leadership (DC)	Extent to which teacher provides leadership to class and holds student attention.	This teacher talks with excitement about her/his subject.
Helpful/Friendly (CD)	Extent to which teacher is friendly and helpful towards students.	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.	We can decide some things in this teacher's class.
Uncertain (SO)	Extent to which teacher exhibits her/his uncertainty.	This teacher seems unsure.
Dissatisfied (OS)	Extent to which teacher shows anger/temper/impatience in class.	This teacher thinks we cheat.
Admonishing (OD)	Extent to which teacher shows unhappiness/dissatisfaction with student.	This teacher gets angry unexpectedly.
Strict (DO)	Extent to which teacher is strict with and demanding of student.	This teacher is strict.

Source: Fisher, Fraser and Wubbels (1993).

The information obtained by means of the questionnaire includes perceptions of the behaviour of the teacher towards the students as a class, and reflects relatively stable patterns of behaviour over a considerable period. One advantage of the QTI is that it can be used to obtain the perceptions of interpersonal behaviour of either students or teachers. When the QTI is administered to both teachers and their students, information is provided about the perceptions of the students of the teacher-student interactions occurring in the classroom of that teacher. The wording of the questionnaire is varied slightly when used to obtain teachers' self-perceptions. For example the question "This teacher explains things clearly", becomes "I explain things clearly" in the teacher self-perception version, and "This teacher would explain things clearly" in the teacher ideal version. Although the wording of items is identical or similar for Actual and Preferred or Ideal versions of students' perceptions, different instructions for answering each are used. For example, 'This teacher help us with our work' in the Actual version is changed to 'The teacher would help us with our work' in the Ideal version. Participants can represent these three sets of data graphically for ease of analysis. For example, Figure 3.3 depicts the information that was provided to a science teacher and visually indicates differences between the teacher's self-perceptions, perceptions of an ideal teacher and how their students perceived him/her.

As the items of the QTI ask about the teacher's behaviour over a long period of time, not just during the current lesson, it has been suggested that teachers and students should interact for a period of two or three months prior to administration of the instrument (Wubbels & Brekelmans, 1981). It has also been suggested that the nature and patterns of the teacher-student interpersonal behaviour that are established during this time are very likely to remain relatively stable for the remainder of the year (Fraser & Walberg, 1981). This suggests that it does not matter when questionnaires are administered so long as the initial two or more months of setting in have taken place.

These studies showed that by using the QTI, it is possible to collect data on students' perceptions of teacher-student interpersonal behaviour and teachers' perceptions of their actual and preferred teachers' interpersonal behaviour in the classrooms, and sets of data can be represented graphically to show differences between the teachers' self perceptions, perceptions of an ideal teacher and how they are perceived by their students, and associations between teachers' interpersonal behaviour and student attitudes.

The QTI is able to be efficiently used by teachers as a tool for self reflection. The three versions of the QTI allow science teachers to obtain their students' perceptions of their interpersonal behaviour, their own perceptions and the behaviour that they consider to be ideal. This valuable information then can be used as a basis for self-reflection by teachers on their teaching performance. Based on this information, teachers might decide to change the way they behave in an attempt to create a more desirable classroom environment.

Figure 3.3 depicts the information that was provided to a science teacher and visually indicates differences between the teacher's self-perceptions, perceptions of an ideal and how their students perceived him/her.

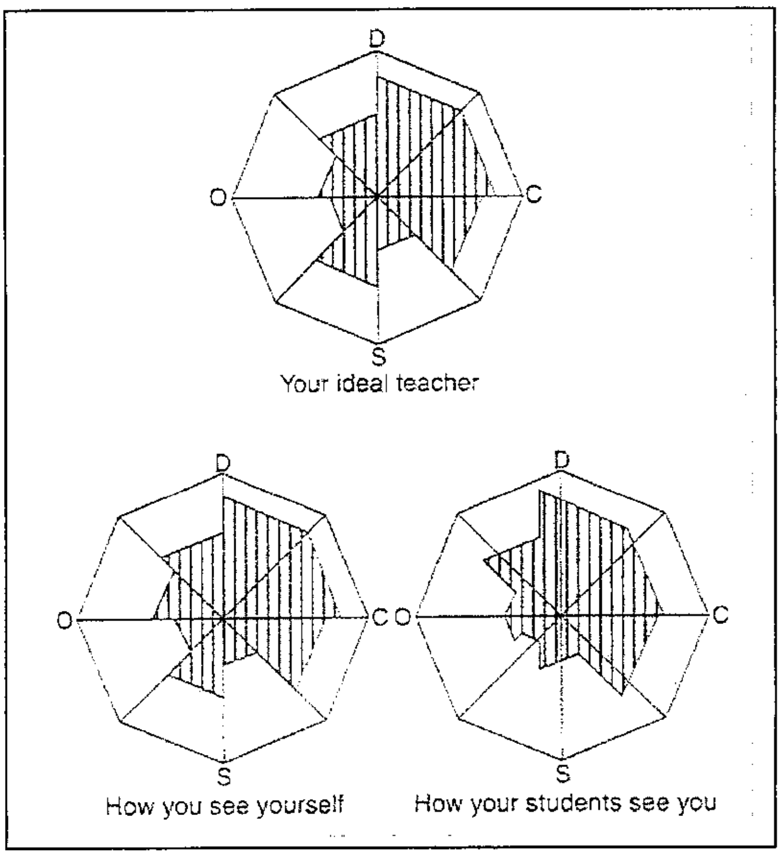


Figure 3.3. Sector profiles of a science teacher (Fisher, Rickards, & Fraser, 1996, p. 28).

Versions of the QTI are available in English, Dutch, Hebrew, Russian, Slovenian, Swedish, and Finnish (Wubbels, Levy, & Brekelmans, 1997) and have been used with more than 50,000 students who completed the QTI for their best and worst teacher. It is not able that a Thai version is not available. Many teachers were surprised to learn that students and teachers agree on the characteristics of good teaching! According to students, the best teachers are strong classroom leaders who are friendlier and more understanding and less uncertain, dissatisfied, and critical than most teachers. Their best teachers also allow them more freedom than the norm. Further, when we asked students about their worst teachers, they described the opposite tendencies. Teachers visualize classroom quality in the same way. In general, then, good teachers are both highly dominant and highly cooperative.

3.2.4 Reliability and Validity of the QTI

The QTI has been used in The Netherlands, USA, Australia, Singapore and a few other Asian countries and has been cross-validated in different contexts and cultures (Fisher & Rickards, 1997; Fisher et al., 1997; Kim, Fisher, & Fraser, 2000). All the studies confirm that data obtained from the questionnaire provide valid, reliable and useful information for the teacher regarding their learning environment in general and more specifically about their teacher-student interactions.

The QTI has been shown to be a valid and reliable instrument when used in The Netherlands (Wubbels & Levy, 1993). When the 64-item USA version of the QTI was used with 1,606 students and 66 teachers in the USA, the cross-cultural validity and usefulness of the QTI were confirmed. Using the Cronbach alpha coefficient, Wubbels and Levy (1991) reported acceptable internal consistency reliabilities for the QTI scales ranging from 0.76 to 0.84 for student responses and from 0.74 to 0. 84 for teacher responses. Table 3.2 shows the Cronbach alpha coefficients of each scale of the QTI in these counties.

Table 3.2
Reliability (Alpha Coefficient) for QTI Scales for Students and Teachers in Three Countries

QTI Scale	Reliability					
	Students			Teachers		
	USA	Australia	The Netherlands	USA	Australia	The Netherlands
Leadership (DC)	0.80	0.83	0.83	0.75	0.74	0.81
Helpful/Friendly (CD)	0.88	0.85	0.90	0.74	0.82	0.78
Understanding (CS)	0.88	0.82	0.90	0.76	0.78	0.83
Student Responsibility/ Freedom (SC)	0.76	0.68	0.74	0.82	0.60	0.72
Uncertain (SO)	0.79	0.78	0.79	0.79	0.78	0.83
Dissatisfied (OS)	0.83	0.78	0.86	0.75	0.62	0.83
Admonishing (OD)	0.84	0.80	0.81	0.81	0.67	0.71
Strict (DO)	0.80	0.72	0.78	0.84	0.78	0.61
Sample Size	1,606	792	1,105	66	46	66

Source: Wubbels and Levy (1993, p.7).

A classroom environment instrument should also be able to differentiate between the perceptions of students in different classrooms (Fraser, Giddings, & McRobbie, 1993). Table 3.3 presents data from Dutch and American samples using a one-way ANOVA with class membership as the main effect. The eta^2 statistic, which represents the proportion of the variance in QTI scores accounted for by class membership, ranged from 0.19 to 0.59, indicating that each scale of the QTI differentiated significantly ($p<0.01$) between the perceptions of students in different classes.

Table 3.3
Ability to Distinguish Between Classrooms (Analysis of Variance) for the QTI in Three Countries

Scale	ANOVA Results (eta^2)		
	Australia (a)	The Netherlands (b)	USA (c)
Leadership (DC)	0.48*	0.59*	0.41*
Helpful/Friendly (CD)	0.33*	0.48*	0.22*
Understanding (CS)	0.29*	0.43*	0.28*
Student Responsibility/Freedom (SC)	0.28*	0.36*	0.29*
Uncertain (SO)	0.38*	0.59*	0.38*
Dissatisfied (OS)	0.20*	0.39	0.19*
Admonishing (OD)	0.23*	0.39*	0.25*
Strict (DO)	0.30*	0.45*	0.43*
Sample size	489	1,105	1,606

*$p<0.01$
Source (a): Henderson, Fisher and Fraser (1995, p. 7)
Source (b & c): Wubbels and Levy (1991, p. 10)

Rickards and Fisher (1998) aimed to provide further validation information for the student and teacher versions of the QTI (in terms of reliability and ability to differentiate between different groups of students) when used with a large Australian sample; to investigate differences in the perceptions of science teachers and their students; and to investigate differences in teachers' actual and ideal perceptions of teacher interactions. The sample was composed of 3,589 students in 173 science classes spread approximately equally between grades 8, 9 and 10 in 35 different schools at the lower secondary levels in two Australian states, namely, Tasmania and Western Australia. Each student in the sample responded to the student version of the QTI while their 164 teachers completed the teacher self and teacher ideal perception versions. This study has found that the three forms of the QTI that examine student and teacher perceptions of the classroom learning environment are valid and reliable instruments that can be used by science teachers to assess teacher-student interpersonal behaviours in their lower secondary science classes in Australia. It showed that there were differences in teachers and students perceptions of teacher-student interpersonal behaviour and that teachers tend to perceive their classes more positively than their students. Differences in teacher actual and teacher ideal perceptions were apparent and tended to suggest that teachers perceived their ideal teacher as being more positive than they currently are.

In summary the QTI has been shown to be a valid and reliable instrument when used in The Netherlands (Wubbels & Levy, 1993). When the 64-item USA version of the QTI was used with 1,606 students and 66 teachers in the USA, the cross-cultural validity and usefulness of the QTI were confirmed. Another use of the QTI in The Netherlands involved investigation of relationships between perceptions on the QTI scales and student learning outcomes (Wubbels, Brekelmans, & Hooymayers, 1991). The Australian version of the QTI containing 48 items was used in studies involving upper secondary science classes in Western Australia and Tasmania (Fisher, Fraser, & Wubbels, 1993; Fisher, Fraser, Wubbels, & Brekelmans, 1993; Fisher, Henderson, & Fraser, 1995; Fisher, Rickards, & Fraser, 1996; Fisher & Rickards, 1997, 2000; Waldrip & Fisher, 2001), and in Indonesia (Soerjansingsih, Nusantara, Fraser, & Aldridge, 2001), Singapore (Khine & Fisher, 2001), Brunei Darussalam (Scott & Fisher, 2001), and India (Koul & Fisher, 2002).

3.2.5 Previous Research Using the QTI

Research has indicated that interpersonal teacher behaviour is an important aspect of the learning environment and that it is related strongly to student outcomes. For example, understanding, helpful/friendly and leadership behaviours of teachers have been found to relate positively to student attitudes and cognitive outcomes (Wubbels, Brekelmans, & Hooymayers, 1991). Levy, Creton and Wubbels (1993) analyzed data from studies in The Netherlands, the USA and Australia involving students being asked to use the QTI to rate their best and worst teachers. Levy, Wubbels, Brekelmans and Morganfield (1997) investigated a sample of 550 high school students in 38 classes comprised of three primary investigation groups, namely 117 Latinos, 111 Asians and 322 students from the United States. The results from this study suggested that the students' cultural background be indeed significantly related to the perceptions that they had of these teachers' interactional behaviour with students in their classes.

Fisher and Rickards (1999) analysed a large database of 2,960 student responses to the QTI and found associations between students' perceptions of teacher-student interactions and students' attitudinal and cognitive achievement outcomes. Seven out of eight scales of the QTI were significantly correlated to attitudes to the class and achievement scores when using simple and multiple correlation. It was found that the scales Leadership, Helping/ Friendly, and Understanding were positively and significantly correlated with the attitude to class and the achievement scores. The other QTI scales Uncertain, Dissatisfied, Admonishing and Strict were negatively correlated to the attitude to class and the achievement scores. Kim et al. (2000) in their study in Korea reported the same correlations.

In one of the first uses of the QTI in Australia (Fisher, Fraser & Wubbels, 1993), associations were investigated between teachers' perceptions of their work environment, using the *School Level Environment Questionnaire (SLEQ)*, and students' and teachers' perceptions of their classroom interactions (Fisher & Fraser, 1991). Results from this study indicated that relationships between SLEQ and QTI scores generally were weak, thus suggesting that teachers believed that they had considerable freedom to shape their own classrooms regardless of their school environment.

Associations between teacher-student interpersonal behaviour and student attitudes was investigated by Fisher, Rickards, and Fraser (1996), who examined students' perceptions of teacher-student interpersonal behaviour on mathematics' teachers with in grades 8, 9 and 10 mathematics classes in Australia and was composed of 405 students in 9 schools with their 21 teachers. The 48-item version of the QTI (Wubbels, 1993) was used to gauge students' perceptions of student-teacher interpersonal behaviour and student attitudes were assessed with a seven-item *Attitude To This Class Scale*, which was based on the *Test of Science-Related Attitudes* [TOSRA] (Fraser, 1981). The results found that the dimensions of the QTI were significantly associated with student attitude scores.

Rickards and Fisher (1996) reported the results for associations between students' perceptions of teacher-student interpersonal behaviour and students' attitudinal and cognitive outcomes when the data were analysed using both simple and multiple correlations. Whereas the simple correlation *(r)* describes the bivariate association between an outcome and a QTI scale, the standardized regression weight *(beta)* characterises the association between an outcome and a particular QTI scale when all other QTI dimensions are controlled with the large database consisting of the responses to the QTI of almost 4,000 students in 185 classes provides further validation data on this instrument.

These associations were positive for the scales on the right side of the model of interpersonal behaviour and negative for the scales on the left side of the model. An examination of the beta weights reveals that the greatest contribution to attitude occurred when teachers exhibited more leadership, helpful/friendly and understanding behaviours in their classrooms and were less strict, dissatisfied and admonishing. Cognitive achievement was higher where the teachers demonstrated more leadership, helpful/friendly and understanding behaviours and less strict, dissatisfied and admonishing behaviours. The more conservative multiple regression indicated that it was the Dissatisfied scale that was negatively associated with cognitive achievement.

Most science teachers would believe that good interactions with the students they teach are important. Rickards and Fisher (1997) used the QTI to study differences in science teachers' perceptions of their actual teacher-student interactional behaviour in the classroom with a sample of 153 teachers and their 3,515 students from 164 secondary school science classes in 35 schools. The results showed that teachers perceived their interactions more positively than did their students, and the researcher also described how science teachers can use the questionnaire to assess perceptions of their own teacher-student interactions and use this as basis for reflecting on their own teaching practice.

A major study, which provided validation data for the QTI with a large Australian sample examined the relationship between teacher-student interpersonal behaviour and student sex, cultural background and student outcomes (Rickards, 1998). This study used a sample of 3,215 students in 158 classes in 43 schools in Tasmania and Western Australia, an attitude to class scale based on the Test of Science-Related Attitude (TOSRA) (Fraser, 1981), a cognitive achievement measure based on items from the Test of Enquiry Skills and a five-item cultural background survey. The study found that there were associations between teacher-student interpersonal behaviour and student sex and that there were differences in the way that students from different cultural backgrounds perceive their learning environments.

Fisher and Rickards (1999) analysed a large database of 2,960 student responses to the QTI and found associations between students' perceptions of teacher-student interactions and students' attitudinal and cognitive achievement outcomes. Seven out of eight scales of the QTI were significantly correlated to attitudes to the class and achievement scores when using simple and multiple correlation. It was found that the scales Leadership, Helping/Friendly, and Understanding were positively and significantly correlated with the attitude to class and the achievement scores. The other QTI scales Uncertain, Dissatisfied, Admonishing and Strict were negatively correlated to the attitude to class and the achievement scores. Kim, Fisher and Fraser (2000) in their study in Korea reported the similar correlations.

Fisher, Rickards, and Newby (2001) compared students' perceptions of teacher-student interactions with those of their teachers by administering the QTI to teachers and students in 80 lower secondary school classes in Tasmania and Western Australia. There are three possible versions of the QTI. Students completed the student version which assesses the students' perceptions of the teacher-student interactions in a specific class. Their teachers completed the teacher actual version of how they perceived their interactions with their students in those same classes. The teachers also indicated how they thought ideal teachers would interact with students by responding to the teacher ideal version. Two multilevel models were proposed: the teacher ideal interaction influences the teacher actual interaction; and the teacher actual affects the student actual and vice versa. Using structural equation modeling techniques, both models were found to be reasonable fits to the data. The results would seem to confirm the underlying basis of the QTI in that the teachers' actual perceptions of their interactions with students affects the students' perceptions, which in turn affect the teachers' perceptions.

Waldrip and Fisher (2001) aimed to identify and describe student perceptions of student-teacher interaction in science teachers' classrooms, using the QTI with a sample of 2,300 science students. Positive associations were found between scales in the right hand side of the model and attitudes while negative associations occurred with scales on the left side of the model.

Waldrip and Fisher (2002) reported student-teacher interactions and with their science teachers to identify exemplary science teachers using the QTI with a sample of 493 science students, and showed that the better teachers could be identified as exemplary teachers through interviews with students. Students' perceptions of the interpersonal behaviour of exemplary teachers were more than one standard deviation above the mean on the scales of Leadership, Helping/Friendly, and Understanding behaviours and more than one standard deviation below the mean on Uncertainty, Dissatisfied and Admonishing scales.

Rickards and den Brok (2003) investigated which student, teacher and class characteristics are associated with students' perceptions of their teachers' interpersonal behaviour, using the QTI. Two important dimensions of teacher interpersonal behaviour were investigated: influence (dominance vs. submission) and proximity (cooperation vs. opposition). Earlier work with the QTI in the United States and the Netherlands has shown that, in those countries, several factors affect students' perceptions of their teachers. These factors include student and teacher gender, student and teacher ethnic background, student age, teacher experience, class size, student achievement and subject. It has been found that each of these variables has a distinctive effect, but also that they interact with each other when determining students' perceptions.

From past research, a number of determinants of classroom learning environment have been identified. Some of these are also determinants of teacher interpersonal behaviour. Teacher gender, grade level, subject, self-esteem and job satisfaction, teachers' cognition, teacher age and experience, and culture have been found to be determinants of teacher interpersonal behaviour (Fisher & Rickards, 1997; Fisher, Rickards, Goh, & Wong, 1997; Goh & Fraser, 1998; Levy, Creton, & Wubbels, 1993; Levy, Wubbels, Brekelmans, & Morganfield, 1994; Rickards, Riah, & Fisher, 1997; Wubbels & Brekelmans, 1997).

3.2.6 The Typology of Teacher Interpersonal Behaviour

The QTI also has been used to develop typologies of teacher interpersonal behaviour in The Netherlands (Wubbels, Brekelmans, Créton, & Hooymayers, 1990). Using cluster analysis, eight types were distinguished. The behavioural patterns on the eight teacher types were characterised as directive, authoritative, tolerant/authoritative, tolerant, uncertain/tolerant, uncertain/aggressive, repressive, and drudging. Teacher types associated with the greatest student cognitive and affective gains were directive (characterised by a well-structured task oriented learning environment) and tolerant/authoritative (characterised by a pleasant well-structured environment in which the teacher has a good relationship with students). Uncertain/aggressive (characterised by an aggressive kind of disorder) and uncertain/tolerant teacher types were associated with the lowest student gains.

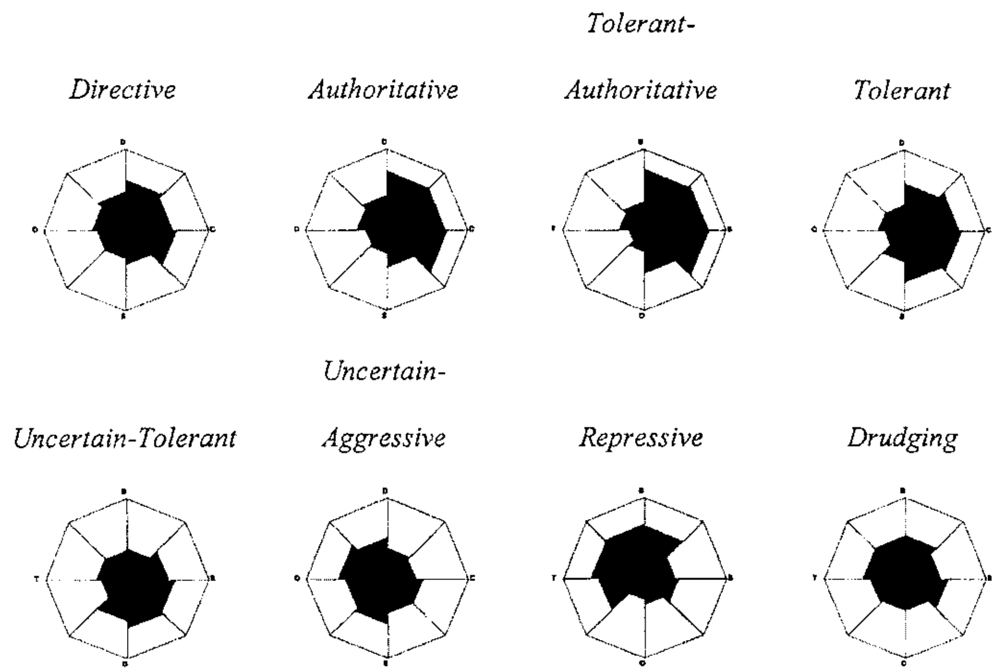


Figure 3.4. Graphical representations of the eight types of patterns of interpersonal relationships (Brekelmans, Levy, & Rodriguez, 1993, p. 36).

Of course, each of the eight interpersonal types has also been linked to student outcomes (Brekelmans, Wubbels, & Levy, 1993). Repressive teachers, followed by tolerant and directive teachers, realised highest achievement. Lowest achievement was found in classes of uncertain-tolerant and uncertain-aggressive teachers. Highest motivation has been found in classes of authoritative, tolerant-authoritative and directive teachers, lowest motivation in classes of drudging and uncertain-aggressive teachers. The pattern found for the tolerant-authoritative teachers approximates the image of the 'best' or 'ideal' teacher closest.

Research also linked the eight interpersonal types to various class and teacher characteristics. For example, Brekelmans, Levy, and Rodriguez (1993) found that directive, authoritative and tolerant teachers realised more reality learning, activity learning and participation learning in their classroom than the other interpersonal types. A later study confirmed these findings by showing that tolerant and authoritative, authoritative and directive teachers realised more active learning in their classroom (Brekelmans, Sleegers, & Fraser, 2000). Teacher experience and age also appeared to be linked to communication type (Brekelmans, et al., 1993; Wubbels, Creton, & Hooymayers, 1987). Older, experienced teachers are represented more frequently between the directive and repressive types. Younger, less experienced teachers appear more frequently in the drudging, authoritative and tolerant categories. Associations have also been found between the way in which teachers would like to relate to the students and the students' view of their interpersonal type (Brekelmans, et al., 1993): drudging teachers prefer to be least dominant and highly cooperative (but never achieve this goal), directive and repressive teachers prefer to be most dominant and only want to show average cooperation. It is argued that repressive teachers, who realise least cooperation, might mistake aggression for dominance, which is one of the reasons why their classes are tense. Drudging teachers have found to be most open to innovation, repressive teachers least inclined to innovate (Brekelmans, et al., 1993). In the Brekelmans study, job satisfaction was not found to relate to teacher-behaviour styles.

Rickards, den Brok, and Fisher (2003) developed the Australian typology of interpersonal teacher behaviour has not been done before. This study reports on the first such typology. Teacher interpersonal behaviour was measured by asking students for their perceptions of their teachers' interpersonal behaviour using the Questionnaire on Teacher Interaction (QTI). Earlier work of the QTI in the later confirmed in an American sample of Secondary school teachers (data from 6,148 students from 283 teachers were combined, resulting in the largest database of student perceptions on the QTI in Australia to date). Frequency distribution and mean scale scores for the existing typology are presented in Table 3.4. As can be seen, more than 85 percent of the teachers could be classified as either being directive, authoritative or tolerant-authoritative. Uncertain-tolerant, uncertain-aggressive and repressive teachers were hardly present in our sample.

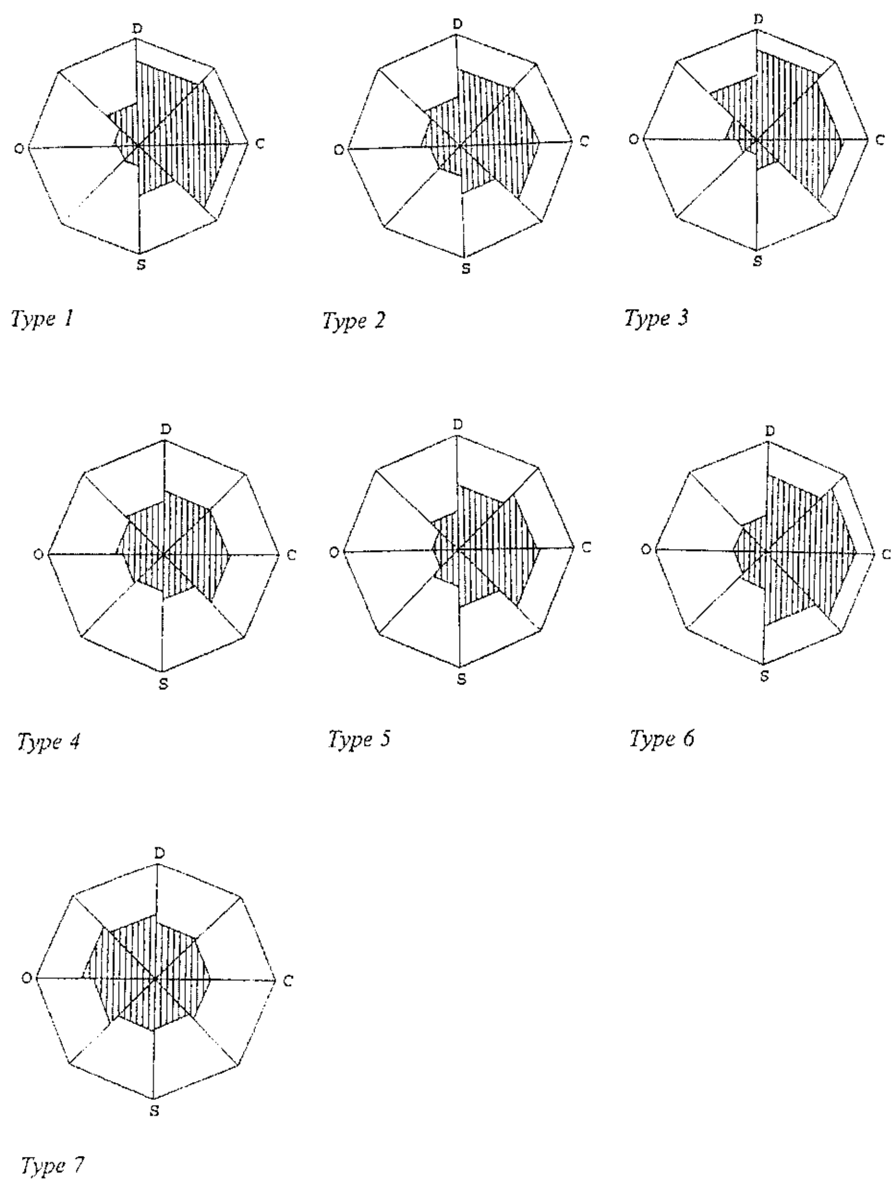


Figure 3.5. Graphical profiles of the Australian typology (Rickards, den Brok, & Fisher, 2003, p.12).

When comparing the percentages in the Australian sample with those of the Brekelmans et al. study, it seems there are more authoritative and tolerant-authoritative teachers in the Australian sample, while the Dutch/US sample contains more tolerant, uncertain-tolerant and uncertain-aggressive teachers. If these findings resemble sampling differences, differences in QTI versions or cultural differences, cannot be determined in this study.

The comparison also indicates that 73.1 percent of the teachers were classified in similar types. Looking at the graphical patterns as displayed in Figure 3.5, these teachers in both samples could be classified as Tolerant/Authoritative (Australian type 1), Authoritative (Australian type 2), Directive (Australian type 4), and Uncertain/Aggressive (Australian type 7). Figure 3.5 shows seven of the graphical profiles of the Australian typology.

Depending on the distribution of these characteristics, perceptions in terms of QTI scales or dimensions, and, consequently, types, might differ, causing possible differences with respect to earlier work on typologies. An alternative explanation might lie in the use of different versions of the QTI: while the Australian version (Fisher, et al., 1993) consisted of 48 items, the American version consisted of 64 items (Wubbels & Levy, 1991) and the Dutch version of 77 items (Wubbels, et al., 1985). However, analyses comparing these three versions of the QTI indicate only minor differences in terms of reliability, construct validity and discriminant validity (den Brok, Fisher, et al., 2003).

One other study investigated how supervising teachers' interpersonal style related to student teachers' satisfaction with their supervision and perceived school climate by the student teachers (Kremer-Hayon & Wubbels, 1993a,b). It was found that supervising teachers with a tolerant-authoritative or authoritative style realised high student teacher satisfaction with supervision, whereas drudging teachers realised low satisfaction in their student teachers. Interestingly, student teachers' perception of the school climate was most positive if their supervising teacher showed a tolerant-authoritative, uncertain-tolerant or drudging interpersonal style.

3.2.7 Studies in Asia

Fisher, Goh, Rickards, and Wong (1997) carried out a similar study involving 720 students in Singapore and 705 students in Australia. In this study the results were the same except that Student Responsibility/Freedom was also positively associated with students' attitudes towards their science classes in both countries. Rawnsley & Fisher (1998) reported the same results in a study involving 490 students in 23, Year 9 classes in Adelaide.

Khine and Fisher (2001) administered the QTI to 1,188 students from 54 science classes in Brunei. This study provided further validation data on QTI and indicated that this tool is a valid and reliable instrument to be used in this context. This study showed that students enjoyed the science lessons more when their teachers displayed greater leadership, understanding and are helping and friendly. On the other hand, teachers' uncertain, admonishing and dissatisfied behaviours were negatively associated with the enjoyment of science lessons.

Soerjaningsih, Nusantara, Fraser, and Aldridge (2001) studied to furnish educators with important insights into the field of learning environments and to provide the associations between teacher-student interpersonal behaviour and achievement outcomes among at the tertiary level of the university students in Indonesia. The What Is Happening In his Class? (WIHIC) Questionnaire was used to measure students' perceptions of the learning environment and the Questionnaire on Teacher Interaction (QTI) was used to measure teacher interpersonal behaviour. Questionnaires were administered with a sample of 422 students in 12 research methods classes to practical information for guiding the improvement of the tertiary computer-related education classes at a private university. To assess students' affective outcomes, two scales were adapted from an existing questionnaire to examine students' attitudes towards the Internet and students' attitudes towards leisure activities in computing. Students' final grade scores for the research methods course was used to provide and indication of students' cognitive outcomes. The data were analysed to describe the learning environment and to examine associations between the learning environment and students' affective and cognitive outcomes at the tertiary level of education in Indonesia.

Scott and Fisher (2001) investigated to the impact of teachers' interpersonal behaviour on examination results in Brunei, using the QTI and a scale for determining students' enjoyment of their science lessons which had been translated into standard Malay. The instruments were validated with a sample of 3,104 students in 136 classrooms in 23 typical, co-educational government primary schools. Associations between students' perception of their teachers' interpersonal behaviours and their external exam results in science were investigated for a subsample of students who sat a national end-of-primary external science examination. Positive and negative correlations were found between cooperative and submissive teacher behaviours, respectively.

Quek, Fraser, and Wong (2001) investigated the impact of teacher-student interaction on students' attitudes towards chemistry for 200 gifted secondary-school students in Singapore. The 48-item QTI and the 30-item Questionnaire Of Chemistry-Related Attitude (QOCRA) were used, and statistically significant associations were found between the interpersonal behavior of the chemistry teachers and students' attitudes towards chemistry. Based on these findings, suggestions for the teacher-student interaction with gifted students are provided.

Koul and Fisher (2003) reported on the results of a large-scale study aiming to determine associations between science students' perceptions of their interactions with their teachers, the cultural background and the gender of the students and their attitudinal and cognitive achievement scores in India. Using the QTI, an attitude scale and questions relating to the cultural background of students with a sample of 1,021 students from 31 year nine and ten science classes in seven schools, researcher found that for cognitive achievement there were positive associations with cooperational behaviour and negative associations with oppositional behaviours.

Koul and Fisher (2004) reported on the results of a large-scale study aiming to determine associations between science students' perceptions of their interactions with their teachers, the cultural background and the gender of the students and their attitudinal and cognitive achievement scores, in Jammu/India. A sample of 1,021 students from 31 year nine and ten science classes in seven schools completed an already existing and widely used instrument the QTI, an attitude scale and question relating to the cultural background of students. The statistical analysis confirmed the reliability and validity of QTI for secondary science students in India. Generally, the dimensions of the QTI were found to be significantly associated with student attitude scores. As for cognitive achievement there were positive associations with cooperative behaviours and negative associations with oppositional behaviours. Females perceived their teachers more positively than did males. Also, students coming from Kashmiri cultural backgrounds perceived their teachers most positively.

3.2.8 Selecting the QTI for this Study

Overall, international research projects utilizing the Questionnaire on Teacher Interaction (QTI), are well established in the literature (Brekelmams, Wubbels, & Creton, 1990; Creton, Wubbels, & Hooymayers, 1993; Fisher, Rickards, & Fraser, 1996; Fisher, Henderson, & Fraser, 1995; Fisher & Rickards, 1997; Fisher, Rickards, Goh, & Wong, 1997; Flinn, 2004; Koul & Fisher, 2003; Levy, Rodriguez, & Wubbels, 1992; McRobbie & Fraser, 1993; Riah, Fraser, & Rickards, 1997; Rickards & Fisher, 1999; Fisher, Rickards, & Newby, 2001; Rickards, Riah, & Fisher, 1997; Soerjaningsih & Fraser, 2000; Waldrip & Fisher, 2001; Wubbels, Brekelmans, & Hermans, 1987; Wubbels & Levy, 1993). Previous studies using the QTI have indicated that the keys to creating or improving learning environments is to emphasise those characteristics which have been found to be linked empirically with desirable student achievement and attitudes.

3.2.9 Summary

The results of these studies further confirmed that the QTI is a valid and reliable instrument that can be used by science teachers to assess teacher-student interpersonal behaviour in their classrooms. Science teachers can make use of the QTI to monitor students' views of their classes, investigate the impact that different interpersonal behaviours have on student outcomes, and provide a basis for guiding teachers' systematic attempts to improve this aspect of their teaching. Furthermore, the QTI could be used in assessing changes that result from the introduction of new curricula or teaching methods, and in checking whether the science teacher's interpersonal behaviour is seen differently by students of different genders, abilities or ethnic background.

In this study, the Thai translation of the QTI version containing 48 items was selected for use in an investigation of students' perceptions of their actual and preferred teacher interpersonal behaviour in physics classes and associations between students' perceptions of their teachers' interpersonal behaviour in physics and students' attitudes toward physics in upper secondary school classes in Thailand.

3.3 THE SCIENCE LABORATORY ENVIRONMENT INVENTORY (SLEI)

In the past 30 years, much attention has been given to the development and use of instruments to assess the qualities of the learning environment from the perspective of the student, and the investigation of the effects of learning environment variables on student outcomes has provided a particular rationale and focus for the use of such instruments. Many researchers have investigated various determinants of learning environment that offer students a learning environment that differs in many ways from the traditional classroom setting. Consequently, the Science Laboratory Environment Inventory (SLEI) (Fraser, McRobbie, & Giddings, 1993) was developed to assess student perceptions of the psychosocial environment of science laboratory classes. This section provides a description of the science laboratory classroom environment, the development of the SLEI, previous research involving the SLEI, cross-cultural validation of the SLEI, and adaptation of the SLEI to create the PLEI, in order to enable an investigation of students' perceptions of classroom laboratory environments in upper secondary school classes in Thailand.

3.3.1 The Science Laboratory Classroom Environment

Laboratory teaching is one the unique features of education in physics, but there is the question of whether the great expense of maintaining and staffing laboratories is really justified (Hofstein & Lunetta, 1982), and whether or not many of the aims of laboratory teaching could be pursued more effectively and at less cost in a non-laboratory setting (Pickering, 1980). Students' reactions to practical work often confirm the views of critics (Fraser, Giddings, & McRobbie, 1992).

Laboratory work is seen as an integral part of most science courses and offers students an environment difficult from that of the conventional classroom. All the classroom environment studies mentioned previously in Chapter 2 were concerned with measuring students' perceptions of psychosocial characteristics of the learning environment in primary, secondary and tertiary classrooms. Although many of these studies were undertaken in science classrooms, it was felt that the instruments used in the studies were of limited appropriateness and applicability for measuring students' perceptions of the science laboratory classroom environment, when considering some of practical tasks undertaken by biology, chemistry and physics students. Thus, the Science Laboratory Environment Inventory (SLEI) was selected for use in this study of laboratory learning environments in physics classes.

3.3.2 Development of the SLEI

The first stage in constructing the SLEI was the development of actual and preferred versions of a Class Form of the instrument (Fraser, McRobbie, & Giddings, 1993). This involved field-testing in six countries involving 3,401 students in 173 senior high schools and 1,242 students in 42 university laboratory classes. The final scales were Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment. Each of the five scales was validated by discussion with students and teachers on the salience of the scales and the wording of the items, by reference to concerns and findings expressed in the research literature on aspects of the science learning environment (Hegarty-Hazel, 1990; Tobin, 1990), coverage of the categories identified by Moos (1979) for conceptualizing all human environments (i.e., Relationship, Personal Development, and System Maintenance and System Change Dimensions) and factor, internal consistency and discriminant validity analysis performed on data collected by administering a preliminary version to students.

Both researchers and teachers have found the SLEI useful to employ classroom climate dimensions as criteria of effectiveness in the evaluation of innovations, new curricula and new teaching methods (Fraser, 1986). Considering the doubts expressed about the effectiveness of laboratory teaching, it is desirable that science teachers make sure of the SLEI to monitors' views of their laboratory classes, investigate the impact that different laboratory environments have on students' outcomes, and use results to provide a basis for guiding systematic attempts to improve these learning environments (Fraser, Giddings, & McRobbie, 1992).

Table 3.4 gives a scale description and a sample item from the Actual Class Form of each SLEI scale. The wording of the preferred version is almost identical except for the use of words, such as 'would'. For example, the item 'Our laboratory class has clear rules to guide student activities' in the actual form is reworded in the preferred version to read, 'Our laboratory class would have clear rules to guide student activities.

The Science Learning Environment Inventory (SLEI) is the only discipline-specific learning environment questionnaire in that it focuses on the science laboratory classroom. The SLEI was first used at the senior high school and higher education levels (Fraser & McRobbie, 1995; Fraser, McRobbie, & Giddings, 1993). It has five scales (each with seven items) with the five response alternatives of *Almost Never, Seldom, Sometimes, Often* and *Very Often.* Field testing and validation of the SLEI was conducted with a sample of 5,447 students in 269 classes across six different countries (USA, Canada, England, Israel, Australia, and Nigeria). Another SLEI study conducted in Brunei by Riah and Fraser (1998), confirmed that each scale of the SLEI displayed satisfactory internal consistency reliability when either the student or the class mean is used as the unit of analysis. The SLEI also differentiated between the perceptions of students in different classrooms and exhibited sound factorial validity. These studies also confirmed the validity of the SLEI in different cultural settings.

Table 3.4

Description Information for Each Scale of the SLEI

Scale name	Moos Category	Description	Sample Item
Student Cohesiveness	R	Extent to which students know, help and are supportive of one another.	I get on well with students in this laboratory class. (+)
Open-Endedness	P	Extent to which the laboratory activities emphasizes an open-ended, divergent approach to experimentation	In my laboratory sessions, the teacher decides the best way for me to carry out the laboratory experiments. (-)
Integration	P	Extent to which the laboratory activities are integrated with non-laboratory and theory classes.	I use the theory from my regular science class sessions during laboratory activities. (+)
Rule Clarity	S	Extent to which behaviour in the laboratory is guided by formal rules.	There is a recognized way for me to do things safety in this laboratory. (+)
Material Environment	S	Extent to which the laboratory equipment and materials are adequate.	I find the laboratory is crowed when I am doing experiments (-)

R: Relationship Dimension; P: Personal Development Dimension; S: System Maintenance and System Change Dimension.
Item designated (+) are scored 1, 2, 3, 4 and 5, respectively, for the responses Almost Never, Seldom, Sometimes, often and Very Often.
Items designated (-) are scored 5, 4, 3, 2 and 1, respectively, for the responses Almost Never, Seldom, Sometimes, often and Very Often.

Source: Fraser, Giddings and McRobbie (1992, p. 3).

3.3.2.1 Development of the Personal Form of the SLEI

Early classroom environment questionnaires have been used to advantage in classroom research, however, these studies suggested the desirability of having a new form of an instrument available which is better suited than is the conventional class form for assessing differences in perceptions that might be held by different students within the same class (Tobin & Fraser, 1987; Tobin, Kahle, & Fraser, 1990). This led Fraser, Giddings, and McRobbie (1992) to develop a different form of a learning environment instrument which asked students for their personal perceptions of their role in the environment of the classroom rather than their perception of the learning environment in the class as a whole; this new forms was named the *Personal Form* as distinct from the previous *Class Form*, respectively.

The Personal Form of the SLEI was developed by rewording items of the Class Form. For example, the item, 'In our laboratory sessions, different students do different experiments' became 'In my laboratory sessions, I do different experiments than some of the other students'. Similar transformations of preferred version items of the Class Form were made in developing a preferred version of the Personal Form. Table 3.8 compares selected Class Forms items (actual version) and the corresponding Personal Form items. Similar transformations of preferred version items of the Class Form were made in developing a preferred version of the Personal Form. It is the Personal Form which provides the focus for the present publication and it is provided in Appendix D (Supplements A and B).

The Personal Form of the SLEI is more appropriate for identifying differences between subgroups of students within a class. For example, gender differences in classroom environment perceptions can be investigated more appropriately with the Personal Form than with the Class Form.

As with most learning environment questionnaires, the SLEI, in addition to a form which measures perceptions of *actual* environment, has a Preferred Form. The Preferred Form focuses on the learning environment ideally liked or preferred by students. Although item wording is almost identical for actual and preferred forms, the directions for answering the two forms instruct students clearly as to whether they are rating what their class is actually like or what they would prefer it to be like. Appendix E contains the Actual Form and the Preferred Form of the SLEI. It can be seen that an item such as "I work cooperatively in laboratory sessions" in the Actual Form is changed to "I would work cooperatively in laboratory sessions" in the Preferred Form.

Table 3.5
Difference in the Wording of Items in the Class and Personal Forms of the Science Laboratory Environment Inventory (SLEI)

Scale name	Class form	Personal form
Student Cohesiveness	Students are able to depend on each other for help during laboratory classes.	I am able to depend on other students for help during laboratory classes.
Open-Endedness	In our laboratory sessions, different students do different experiments.	In my laboratory sessions, I do different experiments than some of the other students.
Integration	The laboratory work is unrelated to the topics that we are studying in ours science class.	The laboratory work is unrelated to the topics that I am studying in my science class.
Rule Clarity	Our laboratory class has clear rules to guide student activities	My laboratory class has clear rules to guide my activities.
Material Environment	The laboratory is crowded when we are doing the experiments	I find that the laboratory is crowded when I am doing the experiments

Source: Fraser, McRobbie and Fisher (1996).

One of the common lines of research with Class Forms of learning environment instruments in the last 30 years has been the investigation of associations between characteristics of the learning environment and various student outcome measures (Fraser, 1994). The administration of the Class and Personal Forms of the SLEI along with an attitude outcome survey to the Queensland sample allowed a comparison to be made of the magnitude of attitude-environment associations for the Class and Personal Forms. Attitudes were assessed with a Likert scale covering a range of chemistry-related attitudes associated with the goals of laboratory teaching, namely, Attitude to Laboratory Learning, Nature of Chemistry Knowledge (testability and changing nature of science knowledge), Cooperative Learning and Adoption of Laboratory Attitudes (e.g., working safely, repeating observations, following instructions). Generally, the strengths of outcome-attitude associations were similar for the Class Form and the Personal Form. Similar results also were reported by Fraser, Giddings and McRobbie (1995) for other attitude outcome measures and an inquiry skills test thus vindicating the development of separate forms of the questionnaire.

Cross-cultural validation information was collected by administering the Personal Form of the SLEI to 1,592 grade 10 chemistry students in 56 classes in Singapore (Wong & Fraser, 1996). For this sample, the alpha reliability figures were quite satisfactory and similar to the Queensland sample using either the individual student or the class mean as the unit of analysis.

3.3.2.2 Actual and Preferred Forms of the SLEI

The actual and preferred versions of the Personal form of the SLEI were administered as part of a study involving the validation cross-validation of the Class Form among senior high school chemistry classes in Queensland, Australia (Fraser, Giddings, & McRobbie, 1995; Fraser & McRobbie, 1995). As part of this larger study which employed a matrix sampling design, all students responded to actual and preferred versions of the Class Form of the SLEI and a general aptitude test. The sample of students who responded to both the Personal and Class forms of the instrument consisted of 516 students in 56 year 11 chemistry classes. This sample enabled a comparison to be made of these two forms of the SLEI. Because the multivariate test the statistically significant (Wilks' lambda, $p < 0.01$), an individual *t*-test was utilized to test the statistical significance of the differences between the scores on the Class and Personal forms for each scale and version. In each instance, the Personal Form mean score was lower than that for the Class form, and this was more pronounced in the preferred version (see in Table 3.6).

Table 3.6
Internal Consistency Reliability (Alpha Coefficient) and Discriminant Validity (mean correlation with other scales) for Actual and Preferred Versions of the Personal Form of the SLEI for Two Units of Analysis, and Ability to Differentiate between Classrooms

Scale	Unit of analysis	Cronbach alpha Reliability			Mean correlation with other scales			ANOVA results (eta^2)	
		Australia Actual	Australia preferred	Sing. actual	Australia Actual	Australia Preferred	Sing. Actual	Australia Actual	Sing. actual
Student	Individual	0.78	0.73	0.68	0.26	0.25	0.23	0.23*	0.10*
Cohesiveness	Class Mean	0.80	0.82	0.83	0.31	0.31	0.30		
Open-	Individual	0.71	0.64	0.41	0.19	0.11	0.03	0.28*	0.08*
Endedness	Class Mean	0.80	0.68	0.54	0.25	0.15	0.05		
Integration	Individual	0.86	0.84	0.69	0.38	0.31	0.30	0.28*	0.18*
	Class Mean	0.91	0.92	0.87	0.44	0.36	0.36		
Rule Clarity	Individual	0.74	0.68	0.63	0.37	0.29	0.28	0.25*	0.19*
	Class Mean	0.76	0.80	0.84	0.43	0.35	0.36		
Material	Individual	0.76	0.73	0.72	0.27	0.34	0.25	0.27*	0.18*
Environment	Class Mean	0.74	0.85	0.82	0.34	0.40	0.31		

The eta^2 statistic (which is the ratio of between to total sums of squares) represents the proportion of variance explained by class membership.
The Australian sample consisted of 516 Grade 11 chemistry students in 56 classes, whereas the Singapore sample consisted of 1,592 Grade 10 chemistry students in 56 classes

*$p<.01$
Source: Fraser, Giddings and McRobbie (1995).

3.3.3 Previous Research Using the SLEI

The present review complements the review of the QTI by focusing on a questionnaire designed especially for science laboratory classes. In particular, a description is given here of a convenient questionnaire which can be used by teachers to obtain a quick and easy assessment of their students' perceptions of their laboratory classroom environment. The dismal reports on practical work in laboratories did not deter many science educators from including practical work as one aspect of science instruction (Blosser, 1988; Duggan & Gott, 1995; Hodson, 1990; Hofstein & Lunetta, 1982; Lazarowitz & Tamir, 1994; Tobin, 1986; White, 1996). Because science educators knew little about the effect of practical work on students' learning and attitudes toward science (Gallagher, 1987), Fraser and his colleagues attempted to advance science educators' understandings of practical work from classroom learning environment perspectives (Fraser, Giddings, & McRobbie, 1992, 1995; Fraser & McRobbie, 1995; Fraser, McRobbie, & Giddings, 1993; Fraser & Wilkinson, 1993). The SLEI was an instrument devised to investigate science laboratory learning environments (McRobbie & Fraser, 1993), and Fisher, Henderson and Fraser (2001) confirmed the reliability and validity of the SLEI in an investigation of associations between students perceptions of the biology laboratory environment and student outcomes.

The SLEI has been used in various contexts, including non-English speaking countries and English-speaking countries. Giddings & Waldrip (1996) found surprisingly similar science larboatory learning environments across most high schools in various countries, with one of the environment scales, Open-Endedness, consistently having the lowest favourable scores. According to Giddings and Waldrip (1996), Australian and American teachers tend to perceive more favourably the scales of Student Cohesiveness and Open-Endedness than do Asian and South Pacific teachers and students. These findings seem to suggest that science teachers are largely unconvinced as to the value of open-ended practical activities in science laboratory classrooms (Giddings & Waldrip, 1996).

Wong and Fraser (1996) investigated Singaporean secondary chemistry students' and teachers' perceptions of their laboratory lessons. They investigated differences in perceptions of actual and preferred chemistry laboratory environments between teachers and students, students of different streams, and male and female students. They examined associations between classroom environment and students' attitudes towards chemistry. They reported that (1) perceptions of students and teachers differed, (2) students wanted to experience more positive laboratory lessons than those presently provided, (3) students from different streams differed only in their preferred perceptions, (4) females held more favourable perceptions than males, and

(5) positive associations existed between the nature of the chemistry laboratory environment and students' attitudinal outcomes.

Using the SLEI, associations with students' cognitive and affective outcomes were found for a sample of 489 senior high school biology students in Australia (Fisher, Henderson & Fraser, 1995) and 1,592 grade 10 chemistry students in Singapore (Wong & Fraser, 1996). Furthermore, several recent studies conducted in Asian countries have contributed to improve the field of learning environment research (Riah & Fraser, 1998). Recently, more studies have been done in some Asian countries, revealing important learning environment features. Among those studies conducted in Asia, the following are noteworthy. Riah and Fraser (1998) explored the environmental perceptions of chemistry theory classrooms and laboratory classrooms in Brunei secondary schools by using the adapted QTI, SLEI and WIHIC. Differences in perceptions between genders were also reported by other researchers (Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 2000).

Harrison, Fisher and Henderson (1997) investigated student perceptions of practical tasks in senior biology, chemistry and physics classes to draw data from student responses to the SLEI and a curriculum analysis of the implemented laboratory tasks with a sample of 387 biology, chemistry and physics students in 20 classes in Tasmania, Australia. The study found that the SLEI differentiated between the three subject areas in following ways: students believed that physics was more open-ended than either biology or chemistry, and the Laboratory Structure and Task Analysis Inventory also confirmed the more open-ended nature of the physics investigations.

Pohl (1999) used the SLEI to evaluate the learning outcomes in environemtal science from a field-based environmental setting using a water quality-monitoring program within a girls' high school and compared the cognitive achievement of students in the water quality-monitoring school with those in non-water quality-monitoring schools. There were associations between the quantitative results and qualitative information in relation to the learning dimension scales of the SLEI.

3.3.3.1 Cross-Cultural Validation of the SLEI

Wong and Fraser (1994) used the SLEI with a sample of 1,592 high school chemistry students in 56 classes in Singapore. This study provided further cross-cultural validation of the SLEI. All scales of the SLEI with the exception of Open-Endedness were found to be positively related to students' attitudinal outcomes and females were found to perceive their environment more favourably than did males on all scales except Open-Endedness where the reverse was true.

3.3.3.2 Associations Between Personally Perceived Environment and Outcomes

One of the common lines of research with Class Forms of learning environment instruments in the last 30 years has been the investigation of associations between characteristics of the learning environment and various student outcomes measures (Fraser, 1994). The administration of the Class and Personal Forms of the SLEI along with an attitude outcome survey to the Queensland sample allowed a comparison of the magnitude of attitude-environment associations for the Class and Personal Forms. Attitudes were assessed with a Likert scale covering a range of chemistry-related attitudes associated with the goals of laboratory teaching, namely, Attitude to laboratory learning, Nature of Chemistry Knowledge, Cooperative Learning and Adoption of Laboratory Attitudes. Simple and multiple correlations were calculated between SLEI scale scores on Personal and Class Forms and each attitude scale for 283 students in 28 year 11 chemistry classroom (Fraser & McRobbie, 1995).

Fraser, Giddings and McRobbie (1991) investigated associations between students' outcomes and their perceptions of the laboratory environment. Students' outcomes were measured by an adapted Test of Science-Related Attitudes (TOSRA) (Fraser, 1981). They found that all SLEI scales except Open-Endedness were significantly and positively associated with attitudinal scales, some significant negative associations with attitudinal outcomes were found. These findings were supported by other studies. In particular, they found the students' attitudinal outcomes were positively associated with Student Cohesiveness, Integration, Rule Clarity, and a better than Material Environment. In relation to cognitive outcomes as measured by examination scores, Integration showed a positive association and Open-Endedness showed negative between them. This finding replicated previous classroom environment studies in non-laboratory classes (Fraser, 1986, 1994).

The SLEI was used by McRobbie and Fraser (1993) to develop a typology of science laboratory learning environments. Responses to the actual form of the SLEI by 4,596 students in 240 classes in four countries suggested that more than 90% of the classes could be assigned to one of eight distinct typologies. The types included such laboratory classrooms as those which were above average on each of the environment scores and could be said to have a moderately positive or supportive environment, those in which the environment was moderately negative, those in which there was a high degree of Integration and a low level of Rule Clarity and Material Environment support, and those which were labelled as supportive open-ended. Furthermore, they concluded that students' attitudinal outcomes varied according to the typology of the class.

Henderson, Fisher and Fraser (1995) studied senior secondary biology classes and laboratories in Tasmania. The study had three objectives. The first objective was to gauge biology students' perceptions of the classroom and laboratory learning environments by means of two instruments, the QTI and the SLEI; and to compare these perceptions with the environments ideally liked or preferred by students. The second objective was to investigate associations between students' cognitive achievement, practical performance and attitudinal outcomes and students' perceptions of the classroom and laboratory learning environments in biology classes. The third objective was to determine the unique and common contributions of the Questionnaire on Teacher Interaction (QTI) and the Science Laboratory Environment Inventory (SLEI) to the variance in biology students' outcomes. The sample of 489 senior high school students in 28 biology classes in Tasmania, Australia. Generally, the dimensions of the SLEI were found to be positively related to student attitude scores. In particular, students' attitude scores were higher in classrooms in which students perceived greater Student Cohesiveness, Integration, and Rule Clarity and a better Material Environment: It was concluded that if biology teachers want to promote favourable student attitudes to their class and laboratory work, they should ensure the presence of these SLEI dimensions in their classrooms.

Lee and Fisher (2001) investigated Korean high school students' perceptions of their laboratory classrooms, focusing on the aspects measured by the items in the Science Laboratory Environment Inventory (SLEI). The study involved 439 high school students from three different streams, 145 from a humanities stream, 195 from a science-oriented stream and 99 from a science-independent stream. The validity and reliability of a translated version of the SLEI were confirmed when used with Korean students. Associations between laboratory classroom environments and students' attitudes were found. When the perceptions of students from the three streams were compared, it was found that students from the science-independent stream perceived their classroom environments more favourably than did students in the other two streams. Interviews with students confirmed their responses to items in the SLEI and provided additional information about laboratory classroom environments in Korea

Quek, Wong and Fraser (2002) investigated the impact of chemistry laboratory environment on student attitudes toward chemistry for 200 gifted secondary-school students in Singapore, using the Chemistry Laboratory Environment Inventory (CLEI- adapted from the SLEI) and Questionnaire on Chemistry-Related Attitudes (QOCRA). Associations were also found between students' perceptions of chemistry laboratory environments and their attitudes towards chemistry.

Newby and Fisher (1998) studied focuses on the computer laboratory class as a learning environment in university courses. In it, two previously developed instruments, the Computer Laboratory Environment Inventory (CLEI) and the Attitude towards Computing and Computing Courses Questionnaire (ACCC) were used. The CLEI (a version of the SLEI) has five scales for measuring students' perceptions of aspects of their laboratory environment. These are Student Cohesiveness, Open-Endness, Integration, Technology Adequacy and Laboratory Availability. The ACCC has four scales, Anxiety, Enjoyment, Usefulness of Computers and Usefulness of the Course. These instruments were administered to a sample of 208 students taking computing courses within the Business School at Curtin University. The sample covered specialist programming courses as well as courses in which the students use software tools such as spreadsheets. With the exception of Laboratory Availability, all the environment variables were found to correlate significantly with all attitudinal variables. The only environment variable with significant association with achievement was Student Cohesiveness. However, the results showed that there were significant associations between the attitudinal variables, Anxiety, Enjoyment and Usefulness of the Course and achievement. Regression analysis supported the findings that the environment variables made a significant contribution to the attitudinal variables, and these in turn made a significant contribution to achievement. This would suggest that computer laboratory environment could affect achievement indirectly by directly affecting students' attitudes.

3.3.3.3 Student Differences in Perceptions of the Science Laboratory Classroom Environment

Previous studies have reported sex-related differences in science students' perceptions of the learning environment (Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 1995; Lawrenz, 1987) and in students' attitudes to science (Catsambis, 1995; Friedler & Tamir, 1990; Keeves & Kotte, 1995). Therefore, in keeping with these lines of research, sex-related differences in students' perceptions of their learning environment and in their attitudinal outcomes were explored. In Fisher and Rickards' (1997) study, statistically significant gender differences were detected in students' responses to classroom environment scales. They found that females perceived their teachers in a more positive way than do males. This has important implications for teachers wishing to change aspects of the classroom environment in order to optimise student outcomes because particular changes might be advantageous to male students but not to female students.

Wong and Fraser (1996) used the SLEI to assess the students' perceptions of their learning environments while adapted versions of the Test of Science-Related Attitudes (TOSRA) were used to measure their attitudes toward science. Analysis of data generated found similar science laboratory learning environments across most secondary schools, with one of the environment scales, Open-Endedness, as the least favourable scale. The analysis also revealed that students in the South Pacific countries had particularly strong attitudes to science. The study raises the possibility that science teaching has its own culture independent of the culture(s) of the country, with an inherent resistance to local adaptation of 'imported' curricula.

Quek, Wong and Fraser (2002) investigated differences in boys' and girls' perceptions of their chemistry laboratory classroom environment using the CLE with a sample of comparison between 312 boys and 185 girls in 18 secondary 4 (year 10) chemistry classes from 3 independent schools in Singapore. Overall, statistically significant differences were found between the boys' and girls' perceptions of their chemistry laboratory classroom environment. This study showed that girls perceived their learning environment more favourably than boys. These differences in perceptions are presented and some implications for chemistry laboratory teaching are discussed.

3.3.4 Adaptation of the SLEI to Create the PLEI

Because one of the purposes of this study is to investigate differences in students' perceptions of their physics classroom environments on the actual and the preferred versions, the researcher decided to adapt the Personal Form of the SLEI for use in the present study. All items of the Personal Form of the SLEI were selected for inclusion in the adapted version. The adapted version was renamed as the Physics Laboratory Environment Inventory (PLEI). However, in order to ensure that the PLEI was suitable for use in Thailand, some items were reworded. Further, because this study was concerned with classroom environments in physics laboratory classes, the word *science* was replaced with *physics*. Table 3.9 shows how items in the SLEI were reworded to form the PLEI items. Thus, the final version of the PLEI contained five scales, namely, Student Cohesiveness (SC), Open-Endedness (OE), Integration (IN), Rule Clarity (RC) and Material Environment (ME).

This study used four aspects to investigate the physics laboratory classroom environments by use of the PLEI. First, to assess whether, the PLEI is a valid and reliable instrument for use in Thailand. Second, to assess students' perceptions of both their actual and preferred classroom laboratory environments in physics classes in Thailand to be used to identify differences between actual classroom environments and those preferred by students. Third, to devise strategies aimed reducing these differences in the students' perceptions of their actual and preferred classroom laboratory environments in physics classes in Thailand and finally, to investigate associations between students' perceptions of their physics laboratory classroom environments and their attitudes toward physics. Classroom environment instruments can be readministered to assess the effectiveness of strategies used in promoting changes. It is recommended that physics teachers use such strategies in conjunction with the PLEI in attempts at improving laboratory class environments. In particular, the proposed method for improving the climate of physics laboratory classes can be especially useful as a basis for development. Research has shown that the administration and scoring of the PLEI can provide an excellent foundation for stimulating fruitful discussion and guiding improvement attempts as part of professional development initiatives.

Table 3.7

Rewording of the SLEI Items for the PLEI

Scale name	SLEI	PLEI
Student Cohesiveness	I get on well with students in this laboratory class.	I get on well with students in this laboratory class.
Open-Endedness	There is opportunity for me to follow my own science interests in this laboratory class.	There is opportunity for me to follow my own physics interests in this laboratory class.
Integration	What I do in our regular science class is unrelated to my laboratory work.	What I do in our regular physics class is unrelated to my laboratory work.
Rule Clarity	My laboratory class has clear rules to guide my activity.	My laboratory class has clear rules to guide my activity.
Material Environment	I find the laboratory is crowded when I am doing experiment.	I find the laboratory is crowded when I am doing experiment.

3.4 ATTITUDES TOWARD SCIENCE

This section reviews some of the literature on the measurement of attitudes towards science. The development and use of several attitude questionnaires is considered and results from attitudinal studies, in particular those investigations that also used the QTI and the SLEI are discussed. Finally, the rationale for selection of an attitude scale appropriate to this study is described.

3.4.1 The Concept of Attitude

Although popular in current usage, meanings given to this term do not always coincide (Koballa, 1988). The term has been used loosely, given its widest meaning to include all educational objectives and outcomes other than those which are strictly cognitive or physical (Mathews, 1974), yet attitude is central to human activity (Shrigley, Koballa, & Simpson, 1988).

We are driven by our interests rather than by our attitudes (Getzels, 1969). The attitude-behaviour link is intuitively appealing. Persuasion research theories of reasoned action and planned behaviour can be used to guide attitude research in science education (Crawley & Koballa, 1994). Even if science educators agree on a definition of relevant science attitudes, there is still confusion regarding the phenomenon of concern in science education about which students should exhibit these feelings or attitudes. Evaluative quality is the central attribute of the attitude concept like or dislike (Shrigley et al., 1988), including terms such as interest, enjoyment, and satisfaction (Gardner & Gauld, 1990) and even curiosity, confidence, and perseverance (Shulman & Tamir, 1972). Thus, it is most important that a study of perceptions of teachers' interactions within classrooms in a non-Western culture includes some measurement of attitudes.

The concept of "scientific attitudes" adds to the confusion. This cognitive concept is typically taken to represent those habits of mind generally associated with critical thinking, the mental processes of a scientist at work (Munby, 1983), and beliefs of scientists rather than expressing personal like or dislike. The three parts of the attitude trilogy are affection, cognition, and conation (Shrigley et al., 1988). Baker

(1985) laments the concept validity of attitude instruments such that all conclusions about attitudes towards science should be regarded as tentative.

3.4.2 Science Attitude Instruments

This section describes the following historically important and contemporary instruments for assessing attitudes toward science: *Scientific Attitude Inventory* (SAI) (Moore & Sutman, 1970); *Test of Interest* (Fraser, 1978b); *Science Curiosity Questionnaire* (Kelly, 1986); *Attitude Toward Science Scale* (Talton & Simpson, 1987); *Attitude Toward School Science* (Harwood & McMahon, 1997); *Attitude Toward Science in School Assessment* (ATSSA) (Germann, 1988); *Wareing Attitudes Toward Science Protocol* (WASP) (Wareing, 1990); *Test of Science-Related Attitudes* (TOSRA) (Fraser, 1981); *Attitude To This Class Scale* (Fisher, Rickards, Goh, & Wong, 1997); and *Attitude To This Subject Scale* (Fraser, 1981). The items in some attitude toward science instruments are shown in Appendix E.

Fraser (1978b) noted that none of the numerous articles reporting the use of the *Test of Interest,* designed to measure ten science and five non-science attitudinal outcomes, provided estimates of scale reliability, and questioned the discriminant validity of the four scales from the Test of Interest measuring student attitude toward four different sources of scientific information, namely conducting an experiment, consulting an expert, reading a book, and asking a teacher.

Simpson and Troost (1982) developed the Attitude Toward Science Scale because they believed that existing instruments were unsuitable for the study of 1,560 biology students in a socially diverse school system in North Carolina, due to students' reading level, item complexity, and low internal consistency of the scale (Talton & Simpson, 1987).

The Attitude Toward School Science Scale, requests students to agree or disagree with general statements on a five point Likert scale (including an option of "undecided") rather than reporting their own experience. Categories of results were combined to obtain groups of students with positive, negative or neutral attitudes school science (Ebenezer & Zoller, 1993).

To measure student attitudes toward science courses; The Attitude Toward Science in School Assessment (ATSSA) was developed and validated when no valid and reliable instrument was available (Germann, 1988). This instrument assesses the single dimension of how students feel toward science as a subject in school, and the degree to which students liked or enjoyed their science lessons. Attitude was found to correlate more with formative scores than with summative examination scores.

The Test Of Science-Related Attitudes (TOSRA), designed to measure seven scales separately, was written for use with secondary school students (Fraser, 1981). TOSRA, frequently used by researchers, curriculum evaluators, and teachers to monitor students' attitudes towards their science class, is especially useful in the monitoring of groups of students so determining differences between various schools of classes.

3.4.3 Classroom Environments and Students' Attitude Towards Science

Wong and Fraser (1996) used the science laboratory classroom environments of secondary schools and the attitudes of secondary science students in Singapore, Australia and countries of the South Pacific were compared in this study. A prevalidated version of the Science Laboratory Environment Inventory (SLEI) was used to assess the students' perceptions of their learning environments while adapted versions of the Test of Science-Related Attitudes (TOSRA) were used to measure their attitudes toward science. Analysis of data generated found similar science laboratory learning environments across most secondary schools, with one of the environment scales, Open-Endedness, as the least favourable scale. The analysis also revealed that students in the South Pacific countries had particularly strong attitudes to science. The study raises the possibility that science teaching has its own culture independent of the culture(s) of the country, with an inherent resistance to local adaptation of 'imported' curricula.

Stolarchuk and Fisher (1998) evaluated the effectiveness of laptop computers in grades 8 and 9 science classrooms, in a sample of Australian Independent Schools. Effectiveness was determined in terms of the impact laptop computers have had on laptop students' attitudinal and achievement outcomes and their perceptions of teacher-student interpersonal behaviour in science classrooms. Students' attitudes to science were assessed using a scale from the Test of Science-Related Attitudes (TOSRA) instrument, achievement was measured using scales from the Test of Enquiry Skills (TOES) instrument and students' perceptions of teacher-student interpersonal behaviour were assessed using the Questionnaire on Teacher Interaction (QTI).

Recently, student attitudes have been assessed using the 7-item Attitude To This Class scale (Fisher, Rickards, Goh, & Wong, 1997; Henderson, Fisher, & Fraser, 1994, 1995, 2000; Henderson & Reid, 2000; Kim, Fisher, & Fraser, 1999, 2000; Yaxley et al., 2000) which was based on the Enjoyment of Science Lessons Scale of the Test Of Science-Related Attitude (TOSRA).

This researcher is interested in student attitudes toward physics and the Attitude to This Subject Scale which was based on the Test Of Science-Related Attitudes (TOSRA) (Fraser, 1981) was deemed the more appropriate to use. This instrument assesses the single dimension of how students feel toward science as a subject in school, and the degree to which students liked or enjoyed their science lessons and science subject.

3.5 OPINIONS OF STUDENTS

In recent years in classroom environment research, qualitative methods have been used in refining questionnaires and in seeking explanations to patterns identified through statistical analysis of quantitative information (e.g., why boys' or girls' perceptions differ, why students' and teachers' perceptions differ; how teacher-student interpersonal behaviour affects student outcomes). Rickards and Fisher (1996) described how this approach was used in a study involving a large-scale use of the Questionnaire on Teacher Interaction in Australia. Following statistical analyses of the responses of about 3,589 science students, in-depth interviews were conducted with students in order to gain student validation of the data collected for each of the scales of the QTI and to examine how interpersonal teacher behaviour related to student attitudes.

Waldrip and Fisher (1998) used a stratified random sampling technique, ten schools were chosen to be involved in the interview component of this study. Students were interviewed concerning their responses to the SLEI. This was particularly important as the analysis of data suggested that in some classes a diverse rang of students' views existed. Three students from each visible position where student confidentiality could be assured, in an interview or counseling room, an open classroom, on school playground seating, or library annex. After ensuring them of the confidentiality of their responses, their approval for audio-recording was obtained. A semi-structured interview was used. Initially, students were asked a general question about their science classroom environment. Secondly, the interview focused on their perceptions of the scales used and thirdly, on responses to individual items. Finally, more detailed explanations were sought about students' perceptions about key concepts by focusing on consistency in their answers.

It was considered important to discover what opinions the students had about their physics laboratories and experimentation as this was suspected to be one of the factors that affected student achievement in physics as in the seven research question: what are the students' opinions about the situation of physics having the lowest average score at the grade 12 level in Thailand?

3.6 SUMMARY OF THE CHAPTER

An important issue related to the development of classroom learning environment instruments is the explanation and amplifying information gained though the use of quantitative methods. Two of the classroom environment instruments in this study are the QTI and the PLEI, which is an adapted version of the SLEI.

This chapter discusses the development of the QTI and its uses in science education research. The QTI has been widely used in classroom research studies and was developed from psychosocial perspectives, being based on a systems approach to communication and personality theory on interpersonal behaviour. The QTI specifically assesses teacher interpersonal behaviour in science classrooms.

Studies have shown that the QTI is a reliable and valid instrument for use in different educational settings. It has been shown to be useful in many research applications, such as investigating interpersonal teacher behaviour in science classes, studying relationships between interpersonal teacher behaviour and students' outcomes and differences in students' and teachers' perceptions of interpersonal teacher behaviour.

The chapter describes the background, development and use of the SLEI and its adaptation for the present study. Because it has been claimed that little is known about the impact of practical work on students' outcomes, it was felt that it was timely to develop an instrument that assesses classroom environment in laboratory settings. Influenced by recent developments in science education, an actual and preferred Personal Form of the SLEI was developed in addition to a conventional Class Form. Interestingly, the SLEI is one of the new classroom environment instruments that have been cross-nationally validated in different countries. Also, it has been found that the SLEI is useful for investigating the nature of the learning environment in laboratory classes, associations between actual and preferred laboratory classroom environments and attitudes toward science. Moreover, the differences found in students' score as the Class and Personal Forms indicate that students have different perceptions when viewing the class as a whole compared with their own roles within the classes.

This study adapted the Personal Form of the SLEI for studying the physics laboratory classroom environment. The reason for choosing the Personal Form was that it could give accurate assessment of the personal roles of individual physics school students in physics laboratory classroom environments. Thus, some items of the SLEI were reworded and the instrument was renamed as the Physics Laboratory Environment Inventory (PLEI). The purpose of the PLEI was to investigate the existing physics laboratory learning environment in upper secondary school classes in Thailand. The version of The PLEI used incorporated modifications made by Wong and Fraser (1995) to the 35-item of the SLEI (Fraser, McRobbie, & Giddings, 1993). Students' attitudes were measured with a short Attitude scale which was based on the Test Of Science-Related Attitudes (TOSRA) (Fraser, 1981a), and associations between students' perceptions of their learning environments and teachers' interpersonal behaviour with their attitudes to their physics classes were selected to be measured.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

The purpose of this research was to describe effects of students' perceptions of physics classroom environments in upper secondary school classes in Thailand, in order to improve the performance of students in physics. In order to have a comprehensive view of the nature of physics classrooms in Thailand, this study focused on the physics laboratory classroom learning environment and physics teacher interpersonal behaviour. Qualitative and quantitative approaches were used. Quantitative data were gathered with every two instruments, namely, the Physics Laboratory Environment Inventory (PLEI) and the Questionnaire on Teacher Interaction (QTI). An Attitude Scale which was based on the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981a) was also used in this study.

However, the PLEI and the QTI questionnaires had not been used in physics classes in Thailand before, therefore, validation of these questionnaires was a necessary part of the study. Also, it was considered important to investigate comparisons between actual and preferred students' perceptions. It was also considered important to investigate associations between students' perceptions of their teachers' interpersonal behaviour and learning environments with their attitudes to their physics classes.

Additionally, before the classroom environment instruments and attitude scale were used in this study, they were translated and adapted for use in Thailand. A group of doctoral students who were studying at Curtin University of Technology assisted in translating the questionnaires from the English version to the Thai version. The process of adaptation involved altering the wording of some of the items and changing instructions on how to answer the instruments. Each instrument is discussed in the following sections.

This chapter describes the research methodology of the study, including a description of the sample for the study, instruments used in the study, administration of the instruments and data analysis.

4.2 SAMPLE

The study consisted of two stages: field-testing and the main study. In the field-testing, 393 physics and other science students who were freshly enrolled at the Udonthani Rajabhat University, Udonthani province, Thailand, in the academic year, 2001, completed the translated versions of the QTI and the PLEI. Cronbach alpha coefficients were calculated for each scale of each instrument. The findings of the field-testing study indicated that the reliabilities of all of scales of the QTI and the PLEI were satisfactory. The QTI scale reliabilities ranged from 0.66 to 0.83, and for the PLEI scales from 0.59 to 0.75.

The main study involved grade 12 students from upper secondary schools in Thailand. There are about 2,669 upper secondary government schools and 120,000 students in the 13 educational regions throughout the 76 provinces of Thailand. Of these, 60% of the schools are in cities, while the other 40% are situated in districts and sub districts. The study was conducted at 233 school classes in 13 educational regions of 76 provinces. From each province, a large city school (over 20 classes in each upper secondary school), a middle district-based school (10-20 classes in each upper secondary school), and a small sub district-based school (less than 10 classes in each upper secondary school) were included in the sample. In addition four school classes from a private school, four school classes from a religious affairs school, and four school classes from demonstration schools attached to government universities were added to the sample. Overall, data were collected using the Thai versions of the PLEI and QTI from a sample of 4,576 students in 245 physics school classes. The distribution of the sample is presented in Table 4.1 and provided in more detail in Appendix D.

Prior to contacting schools and requesting permission to collect data on teacher-student interactions, learning environments and attitudes to physics classes, ethical clearance was obtained fro m Curtin University of Technology. The setting up of the sample and the consequent collection of data were then able to proceed.

Table 4.1
Sample of Upper Secondary Schools in the Provinces in Thailand

Edu. Regi.	Province	Name of school class properties of sample: A large city school	A district–based middle school	A sub district-based small school
1	Nakorn Pratum	Praphatom Wittayalai S	King College	Sirindhorn Princess Wittayalai
2	Yala	Khanaraj Bumrung	Satri Yala	Ramaun Siriwit
3	Songkla	Hadyai Wittayalai	Woranari Chalerm	Natawi Wittaya
4	Phuket	Satri Phuket	Muang Thalang	Chalermprakeit Somdej Prasrinakarin
5	Petchaburi	Phrommanusorn	Churapornrajcha Wittayalai	Cha-um Khunying Nuingburi
6	Ang Thong	Ang Thong Puttamarot	Satri Ang Thong	Pamok Wittayaphum
7	Pitsanulok	Pitsanulok Pittayakom	Nakhorn Thai	Wat Boat Suksa
8	Chiang Mai	Wattanothai Payab	Navaminrachutit Payab	Sarapi Pittayakom
9	Udon Thani	Udon Pittayanukul	Nong Han Wittaya	Nanokchum Wittayakom
10	Ubon Ratchathani	Nari Nukul	Dej Udom	Warin Chumrab
11	Nakhon Ratchasima	Ratchasima Wittayalai	Pak Chong	Sida Wittaya
12	Sa Kaeo	Sa Kaeo	Arunyaprates	Thakaserm Wittaya
13	Bangkok	Trium Udom Suksa (Group 2)	Panya Worakun (Group 8)	Wat Noi Nai (Group 6)
	Private School	Prince Royal School (Cheing Mai)	Dara Wittayalai School (Cheing Mai)	Rachinibon School (Bangkok)
	Demonstration School of University	Kasetsat University	Cheing Mai University	Khon Kaen University
	Religious Affairs School	Wat Srisaket (Nong Kai)	Wat Pra Tat Doi Sutep (Cheing Mai)	Wat Sommanut Wararam (Udon Thani)

The students were enrolled in one semester of physics courses, covering one academic year. Group interviews with students in a sub-sample of about 5% of the 4,576 students (200 students) were an essential source of information to guide revisions to the questionnaires designed for this study.

The average class size was 30, but ranged from seven to 55 students. The sample was representative of the population of students talking grade 12 level physics in the Ministry of Education's upper secondary schools in the academic year 2002, in Thailand.

4.3 QUESTIONNAIRES

4.3.1 Questionnaire on Teacher Interaction (QTI)

The Australian version of the Questionnaire on Teacher Interaction (QTI) developed by Wubbels (1993) was selected for use in this study. This instrument was adapted and used specifically for measuring teacher-student interactions in terms of teachers' interpersonal behaviour towards students in physics theory classes. The QTI has eight scales with each scale containing six items. The scales of the QTI are Leadership, Helpful/Friendly, Understanding, Student Responsibility and Freedom, Uncertain, Dissatisfied, Admonishing and Strict. A description of each of the QTI scales is shown in Table 4.2.

The QTI uses a five-point responses format (from Never to Always), which requires students to circle the response alternatives on the questionnaire itself. Further details of the QTI and its adaptation are described in Chapter 3 and the questionnaire itself is presented in Appendix D.

Table 4.2
Description of Scales and Sample Items for each Scale of the QTI

Scale name	Description	Sample item
Leadership (DC)	Extent to which teacher provides leadership to class and holds student attention.	This teacher talks with excitement about her/his subject.
Helpful/Friendly (CD)	Extent to which teacher is friendly and helpful towards students.	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.	We can decide some things in this teacher's class.
Uncertain (SO)	Extent to which teacher exhibits her/his uncertainty.	This teacher seems unsure.
Dissatisfied (OS)	Extent to which teacher shows anger/temper/impatience in class.	This teacher thinks we cheat.
Admonishing (OD)	Extent to which teacher shows unhappiness/dissatisfaction with student.	This teacher gets angry unexpectedly.
Strict (DO)	Extent to which teacher is strict with and demanding of student.	This teacher is strict.

Source: Fisher and Rickards (1997).

4.3.2 Physics Laboratory Environment Inventory (PLEI)

The PLEI was adapted form the Personal form of the Science Laboratory Environment Inventory (SLEI) developed by Fraser, Giddings and McRobbie (1995) for measuring the science laboratory classroom environment. The development of the SLEI and its adaptation to form the PLEI are discussed Chapter 3.

The instrument has five scales with seven items in each scale. The scales are Student Cohesiveness, Open-Endedness, Integration, Rule Charity and Material Environment. The instrument uses a five-point response format (Almost Never, Seldom, Sometimes Often and Very Often). Students are required to circle their response alternatives on the questionnaire itself. The instrument was statistically validated before it was used to measure the classroom environment of physics laboratory classes in Thailand in the present study. The questionnaire can be found in Appendix E.

4.3.3 Attitude Scale

This study investigated associations between students' perceptions of their teachers' interpersonal behaviour, and their physics laboratory classroom environments and their attitudes toward physics in upper secondary classes in Thailand. An attitude scale previously validated by Fraser (1981) was selected for this research. Because the scale was intended to measure students' attitudes in all subjects, the wording of the items was modified by replacing the word *This Subject* with *Physics.* For example, an item in the original version, which was worded as "I look forward to lessons in this subject", was reworded in the modified version to, "I look forward to lessons in physics" for physics classes. The selection and adaptation of the Attitude Scale and its adaptation are discussed in Chapter 6 and the scale is presented in Appendix F.

4.3.4 Students' Interviews

Interviews are an important source of data in this study. In an open-ended interview, with groups of students, the researcher asked the informants about, age, gender, physics' grade in past semesters, interest in science subjects, difficulty in learning science, interest in future studies in science, experience, kinds of physics' learning, factors that should help improve students' learning achievement and factors of why the lowest average scores are in physics. Sixteen questions were used in the interviews and this process is discussed further in Chapter 7.

4.4 ADMINISTRATION OF THE INSTRUMENTS

The researcher himself administered the instruments to students. A suitable time for administering the instruments was negotiated with each of the schools. This was done to ensure that disruption to lessons was minimized. The schools agreed to devote time during physics classes for the study. The first occasion involved using the Preferred Forms of the PLEI and the QTI during November and December, 2002.

The second occasion involved the actual forms of the PLEI, the QTI, and the Attitude Scale and at that time conducting interviews were also conducted. The completion of the PLEI and QTI was not a lengthy process, and involved only about 25 minutes of class time for each instrument. The follow-up interviews only involved about 5% of the sample. At all times the participants remained anonymous and each had the right to withdraw from the study at any time.

4.5 DATA ANALYSIS

Quantitative data were obtained using the three questionnaires (QTI, PLEI and Attitude scale), student opinions were obtained with the additional qualitative data were obtained from interview. Appropriate statistical procedures were selected to determine whether the Thai versions of the PLEI and the QTI questionnaires are valid and reliable. These were those tests traditionally used with learning environment questionnaires: factor analysis, internal consistency reliability, and ability to differentiate between students in different classrooms. Simple and multiple correlation analyses were used with the actual versions. A *t*-test for correlated samples was used for each individual PLEI and QTI scale to investigate whether students have significantly different perceptions of their actual and preferred classrooms. All data collected remained confidential and all respondents were volunteers and had given signed permission.

An interview was the most important sources of data of this study. In an open-ended interview students were asked to discuss their physics' grades in past semesters, interest in science subjects, difficulties in learning science, interest in future studies in science, experience, kinds of physics' learning, factors that should help improve students' learning achievements and factors of why the lowest average scores are in physics.

4.6 SUMMARY OF THE CHAPTER

This chapter describes the study's sample, instruments, procedures for administering the instruments, and statistical procedures for data analysis. The study involved 4,576 students in grade 12 upper secondary education physics classes under the

Ministry of Education and Ministry of Governmental Universities of Thailand. The instruments used in the study were the PLEI, QTI and Attitude Scale. Group interviews were conduced with about 5% of the sample.

The study was conducted in two stages, namely, a field-testing and the main study. For field-testing, the researcher himself went to the physics classes to administer the instruments personally. The purposes of the field-testing were to produce learning materials to gather the teachers' interpersonal behaviour and to encourage physics teacher to assess the environments of the physics classrooms and laboratories.

The research described in this thesis employed both quantitative and qualitative approaches utilizing the QTI, the PLEI and attitude questionnaires and focus groups for interviews. The qualitative data from the interviews was included to help improve the accuracy and relevance of quantitative studies. The combination of approaches allowed a deeper understanding of the results.

Figures 4.1 to 4.3 show the laboratory classroom learning environments in physics classes as observed by the researcher and Figure 4.4 shows the interview situation.

Figure 4.1. The physics classroom learning environment before having activities in teaching and learning.

Figure 4.2. The physics classroom learning environment during activities.

Figure 4.3. The physical classroom learning environment.

Figure 4.4. Interview situation.

CHAPTER 5

VALIDATION OF QUESTIONNAIRES

5.1 INTRODUCTION

A summary of statistical information currently available for the four instruments (QTI, PLEI and Attitude Scale) was considered previously and this included information about each scale's internal consistency reliability (alpha coefficients), discriminant validity (using the mean correlation of a scale with the other scales in the same instrument as a convenient index), and the ability of a scale to differentiate between the perceptions of students in different classrooms. These instruments have not been used before in physics classes in Thailand, therefore, it was necessary to validate them in the Thai context. This chapter contains three further sections, namely, the QTI, the PLEI, and the Attitude Scale. This chapter provides and answers to Research Questions 1 and 2.

5.2 VALIDATION OF THE QUESTIONNAIRE ON TEACHER INTERACTION (QTI)

In keeping with previous learning environment studies, the following analyses were conducted to determine the reliability and validity of the QTI. The internal consistency of each scale was determined by using the Cronbach's alpha reliability. The QTI is a circumplex model which means that correlations between a scale and the scale next to it generally is high, and becomes lower for scales further away from it. Correlations between the scales of the QTI were calculated in order to check this. The QTI's ability to differentiate between classrooms was also investigated.

The internal consistency reliability of the QTI version used in this study was determined by calculating Cronbach alpha coefficients for the scales of the QTI using both actual and preferred students' scores. Table 5.1 reports the internal consistency of the QTI, which ranged from 0.60 to 0.84 when using the students' actual scores and from 0.57 to 0.78 when using the students' preferred scores.

Table 5.1
Scale Internal Consistency (Cronbach Alpha Reliability) and Ability to Differentiate Between Classrooms (ANOVA) for the QTI

Scale	Form	Alpha Reliability	Discriminant Validity	ANOVA (*Eta*^{2})
Leadership	Actual	0.79	0.46	0.26*
	Preferred	0.74	0.45	
Helping/Friendly	Actual	0.82	0.37	0.28*
	Preferred	0.78	0.42	
Understanding	Actual	0.75	0.38	0.26*
	Preferred	0.73	0.47	
Student Responsibility/	Actual	0.60	0.20	0.27*
Freedom	Preferred	0.57	0.43	
Uncertainty	Actual	0.68	0.35	0.27*
	Preferred	0.59	0.32	
Dissatisfied	Actual	0.84	0.40	0.29*
	Preferred	0.75	0.32	
Admonishing	Actual	0.63	0.46	0.26*
	Preferred	0.61	0.51	
Strict	Actual	0.69	0.24	0.28*
	Preferred	0.70	0.28	

** Correlation is significant at the 0.001 level (2-tailed)*

These results suggest that the QTI is a reliable instrument for use in physics classes in Thailand although some caution needs to be taken when considering the results from the use of the Student Responsibility and Freedom scale.

Another criterion for establishing the validity of this learning environment instrument is its ability to differentiate between the perceptions of students in different classroom. It is assumed that students in different classes would perceive different environments from those within their own classes. This characteristic was explored using a series of one-way analyses of variance on the scales of the QTI. The last column in Table 5.1 reports the result of the analyses, which suggests that each scale of the QTI was able to differentiate significantly (p<0.001) between classes. The *eta*^{2} statistic which is the ratio of "between" to "total" sums of squares and represents the proportion of variance in scale scores accounted for class by membership, ranged from 0.26 to 0.29 for different scales.

To investigate the circumplex nature of the QTI, correlations between the scales were calculated. The results are presented in Tables 5.2 and 5.3. As expected, the results show that the correlation between a scale and the scale next it generally is high, and becomes lower for scales further away from that scale. This is illustrated using the Helping/Friendly scale in Figure 5.1. In general, the circumplex nature of the QTI has been cofirmed.

Table 5.2
Scale Intercorrelations for the QTI Using the Actual Form.

Scales	HFr	Und	Sre	Unc	Dis	Adm	Str
Lea	.58**	.74 **	.45**	-.41**	-.36**	-.46**	-.20**
HFr		.61**	.64**	-.18**	-.26**	-.35**	-.10**
Und			.04**	-.30**	-.36**	-.52**	-.12**
Sre				-.04**	-.00	-.18**	-.08**
Unc					.64**	.60**	.27**
Dis						.70**	.50**
Adm							.38**
Str							

***Correlation is significant at the 0.01 level (2-tailed)*

Table 5.3
Scale Intercorrelations for the QTI Using the Preferred Form.

Scales	HFr	Und	Sre	Unc	Dis	Adm	Str
Lea	.55**	.73 **	.41**	-.37**	-.38**	-.52**	-.20**
HFr		.57**	.56**	-.22**	-.33**	-.42**	-.32**
Und			.49**	-.34**	-.39**	-.53**	-.27**
Sre				-.05**	-.13**	-.32**	-.17**
Unc					.52**	.39**	.32**
Dis						.46**	.48**
Adm							.23**
Str							

***Correlation is significant at the 0.01 level (2-tailed)*

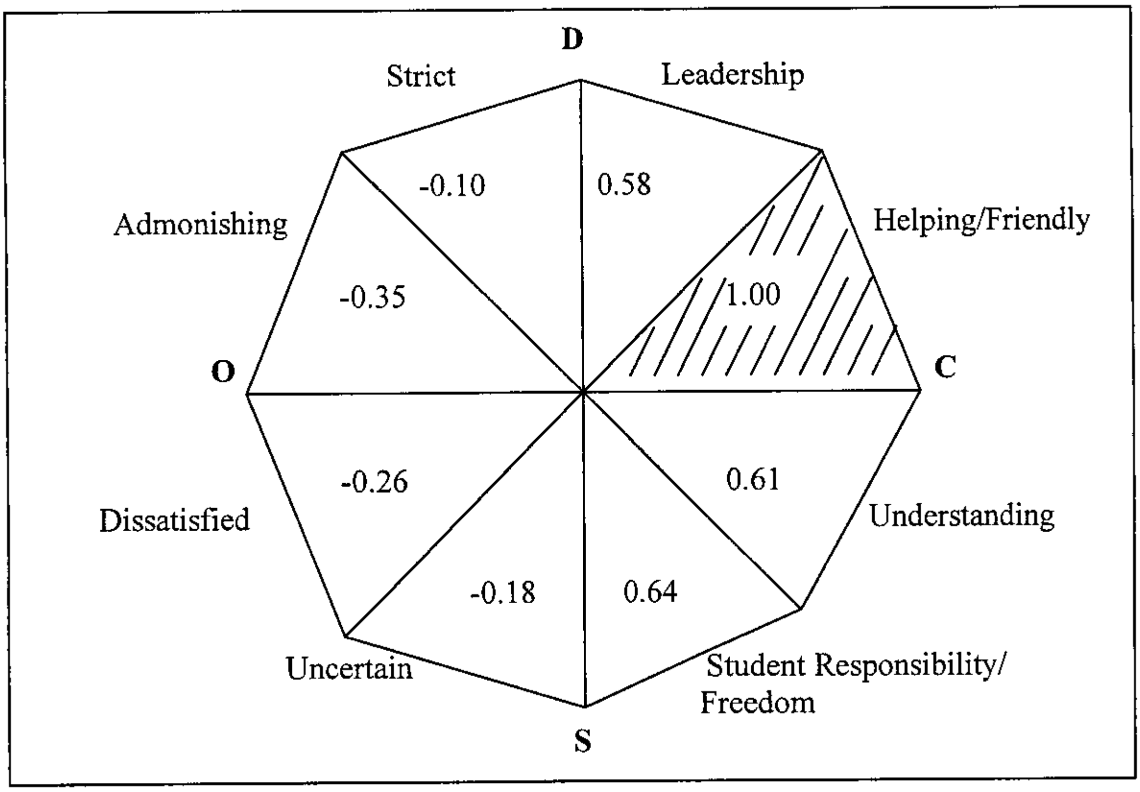


Figure 5.1. Correlations of Helping/Friendly scale with other QTI scales using Actual Form.

Overall, these analyses have shown that the QTI is a reliable and valid instrument for assessing students' perceptions of their teacher interpersonal behaviour in their physics classes and it may be used in an actual or preferred version. Discussions of the results of using the QTI are provided in the next two chapters.

5.3 VALIDATION OF THE PHYSICS ENVIRONMENT INVENTORY (PLEI)

Internal consistency (Cronbach alpha coefficient) and the mean correlation of each scale with the other scales were obtained for the sample in this present study as indices of scale reliability and discriminant validity for the PLEI. A summary of these values obtained separately for the Actual and Preferred Forms of the PLEI is report in Table 5.4.

Table 5.4
Scale Internal Consistency (Cronbach alpha reliability), Discriminant Validity (Mean Correlation of a Scale with Other Scales) and Ability to Differentiate between Classrooms (ANOVA) for the PLEI

Scale	Form	Alpha Reliability	Discriminant Validity	ANOVA (*Eta*^{2})
Student Cohesiveness	Actual	0.70	0.37	0.18*
	Preferred	0.61	0.43	
Open-Endedness	Actual	0.61	0.21	0.18*
	Preferred	0.67	0.37	
Integration	Actual	0.64	0.39	0.17*
	Preferred	0.66	0.49	
Rule Clarity	Actual	0.61	0.47	0.19*
	Preferred	0.63	0.52	
Material Environment	Actual	0.60	0.42	0.20*
	Preferred	0.58	0.51	

* *Correlation is significant at the 0.01 level (2-tailed)*

As reported in Table 5.4, the reliability coefficients for the different PLEI scales ranged from 0.60 to 0.70 when using the Actual Form and from 0.58 to 0.67 for the Preferred Form when using the individual student as the unit of analysis. On the whole, these results are acceptable although somewhat lower in value than obtained previously in the original validation sample (Fraser et al., 1992b).

The discriminant validity coefficients (the mean correlation of a scale with the other scales) of the physics classroom environment ranged from 0.21 to 0.47 for the Actual Form and from 0.37 to 0.52 for the Preferred. These figures suggest that the scales of the PLEI measure distinct although somewhat overlapping aspects of the physics laboratory environment. The distinct nature of the scales also was checked with a factor analysis described later.

The 35-item PLEI was also subjected to a series of one-way analyses of variance. As shown in Table 5.4, the *eta*^{2} statistic ranged from 0.17 to 0.20 for different scales. It was confirmed, that each scale differentiated significantly ($p<0.001$) between perceptions of students in different classrooms.

Table 5.5
Factor Loadings for Items in the Actual Form of the PLEI

	Factor Loading				
Item No.	Student Cohesiveness	Open-Endedness	Integration	Rule Clarity	Material Environment
11	.70				
16	.70				
31	.69				
1	.59				
26	.58				
21	.47				
6	.35				
17		.71			
2		.65			
32		.63			
22		.63			
7		.57			
12		.51			
27		.38			
8			.72		
33			.70		
3			.60		
23			.58		
28			.54		
18			.47		
13			.47		
14				.67	
4				.65	
29				.65	
19				.63	
34				.53	
24				.44	
9				.35	
20					.71
10					.59
25					.59
35					.58
15					.53
5					.42
30					.36
% of variance	36.47	32.90	32.64	31.19	30.29
Eigenvalue	2.55	2.30	2.29	2.18	2.12

**Loading smaller than .3 omitted. The sample consisted of 4,576 students in 245 classes*

Table 5.6
Factor Loadings for Items in the Preferred Form of the PLEI

	Factor Loading				
Item No.	Student Cohesiveness	Open-Endedness	Integration	Rule Clarity	Material Environment
31	.70				
16	.68				
11	.64				
26	.60				
6	.54				
1	.46				
21	.45				
17		.67			
32		.64			
22		.64			
7		.60			
2		.59			
12		.53			
27		.33			
33			.65		
13			.62		
8			.61		
28			.59		
18			.54		
3			.53		
23			.49		
14				.68	
19				.66	
29				.65	
4				.61	
34				.55	
24				.52	
9				.46	
10					.67
35					.67
20					.67
30					.55
25					.52
15					.46
5					.36
% of variance	31.59	34.35	33.30	32.11	29.94
Eigenvalue	2.21	2.41	2.33	2.25	2.10

**Loading smaller than .3 omitted. The sample consisted of 4,576 students in 245 classes*

The Actual and Preferred Forms of the PLEI were subjected to separate principal components factor analyses (with varimax rotation) involving the individual student's score. The factor structure that emerged replicated, to a large extent, the structure reported previously for the SLEI (Fraser, Giddings, & McRobbie, 1992b). Tables 5.5 and 5.6 list the items which were found to have factor loadings greater than 0.30 (which is the minimum value conventionally accepted as meaningful in factor analysis).

On the whole, it appears that the items had factor loadings greater than 0.30 with their *a priori* scales, and hence, the results lend support to the factorial validity of the PLEI.

From the analyses, the PLEI has been found to be a reliable and valid instrument for assessing students' perceptions of their physics laboratory classroom environment, and provides validation support for its use specifically in Thailand, in both its Actual and Preferred Forms. Further discussions of the application of the PLEI results are given in the following two chapters.

5.4 VALIDATION OF THE ATTITUDE SCALE

To measure students' attitudes towards physics studies, the present study adapted the seven-item *Attitude to This Class Scale* (Fisher, Rickards, Goh, & Wong, 1997; Henderson, Fisher, & Fraser, 1994, 1995, 1998, 2000; Henderson & Reid, 2000; Kim, Fisher, & Fraser, 2000; Yaxley, Fisher, & Fraser, 2000); which was based on the *Test of Science Related Attitudes* (TOSRA) (Fraser, 1981). Using internal consistency reliability the Attitude scale had a value of 0.69 which was considered satisfactory for further use in this study.

5.5 SUMMARY OF THE CHAPTER

In this chapter, appropriate statistical procedures were used, in order to validate the questionnaires. The procedures included factor analysis, item analysis, Cronbach alpha, discriminant validity and one-way ANOVA. The three instruments, namely, the Physics Laboratory Environment Inventory (PLEI), the Questionnaire on Teacher Interaction (QTI) and the Attitude Scale are valid and reliable for use in Thailand's upper secondary schools.

CHAPTER 6

QUANTITATIVE RESULTS

6.1 INTRODUCTION

This chapter presents a comparison between actual and preferred students' perceptions in physics classrooms in Thailand. Associations between students' perceptions of teachers' interpersonal behaviour and learning environments with their attitudes to their physics classes are also discussed. A typology of physics teachers in Thailand in relation to their interpersonal behaviour is presented. Statistical analyses including information about each scale's mean scores, standard deviations, mean differences, and comparisons of means by *t*-tests are presented. The results presented in this chapter provide answers to Research Questions three to six.

6.2 STUDENTS' PERCEPTIONS OF THEIR ACTUAL AND PREFERRED TEACHERS' INTERPERSONAL BEHAVIOUR

The actual and preferred perceptions of 4,576 students of their teachers' interpersonal behaviour in physics classrooms were measured with the QTI. The results given in Table 6.1 show the mean scores, for each of the eight QTI scales. As each scale has six items, the minimum and maximum scores for each scale would be 0 and 24, respectively. The statistical significance of the difference between actual and preferred means was estimated using paired comparisons between different forms of the same scale using *t*-tests for dependent samples.

Table 6.1
Scale Means, Standard Deviations and Mean Differences for Actual and Preferred Forms of the QTI

Scale	Means		Standard Deviations		Mean Diff.	*t*-value
	Actual	Preferred	Actual	Preferred		
Leadership	18.05	20.49	3.68	2.90	2.44	35.12**
Helping/Friendly	16.08	19.35	4.61	3.71	3.27	37.67**
Understanding	17.36	19.75	3.67	3.20	2.38	32.47**
Student Responsibility/Freedom	14.94	16.68	3.37	3.26	1.74	25.42**
Uncertain	8.68	7.06	3.97	3.58	-1.62	20.66**
Dissatisfied	8.71	6.41	5.21	4.21	-2.30	23.24**
Admonishing	6.25	4.41	3.45	3.03	-4.26	27.53**
Strict	13.30	10.62	4.17	4.62	-2.67	28.76**

*n = 4,576, *p<0.05, **p< 0.01, ***p< 0.001*

The scale means ranged from 6.25 to 18.05 on the Actual Form, and from 4.41 to 20.49 on the Preferred Form. Standard deviations for the Actual Form ranged from 3.37 on the Student Responsibility/Freedom scale to 5.21 on the Dissatisfied scale, whereas on the Preferred Form, standard deviations ranged from 2.90 on the Leadership scale to 4.21 on the Dissatisfied scale. The mean differences between the students' responses to the Actual and Preferred Forms ranged from -4.26 (preferred – actual) on the Admonishing scale to 3.27 (preferred – actual) on the Helping/Friendly scale. Table 6.1 reveals that the differences between the Actual and Preferred Forms of the QTI scales were statistically significant at the 0.01 level for all of the eight scales.

In most cases, the standard deviations of the students' perceptions of actual teacher behaviour are higher than the standard deviations of preferred teacher behaviour for seven of the eight scales. The presence of more variation in the majority of the actual teacher interpersonal behaviour than in the majority of the preferred teacher interpersonal behaviour may indicate that students are more agreed about preferred teacher interpersonal behaviour.

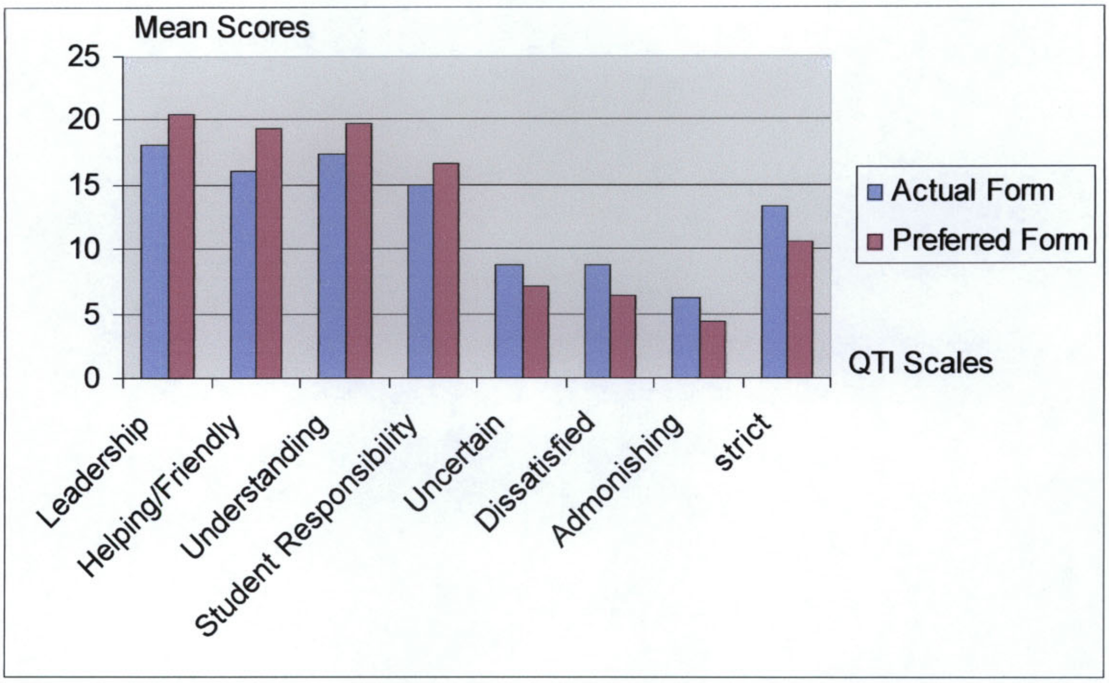


Figure 6.1. Significant differences between students' perceptions of their actual and preferred scores on the QTI.

Figure 6.1 presents a pictorial comparison of the Actual Form with the Preferred Form and indicates that students would prefer more leadership, helping/friendly and understanding behaviours in their teachers and would prefer to be given more responsibility and freedom. However, they would prefer less uncertain, dissatisfied, admonishing and strict behaviours.

The finding also further supports previous related research in that a variety of studies has indicated that students prefer a more positive learning environment than they actually perceive to be present (Fisher, Henderson, & Fraser, 1995; Fisher, Fraser, & Wubbels, 1993; Fisher, Fraser, Wubbels, & Brekelmans, 1993; Fisher & Rickards, 1999; Fisher, Rickards, & Fraser, 1996; Fisher, Rickards, & Newby, 2001; Goh & Fraser,1998; Khine & Fisher, 2001; Koul & Fisher, 2003; Quek, Fraser, & Wong, 2001; Quek, Wong, & Fraser, 2002; Rickards & Fisher, 1998; Scott & Fisher, 2001; Soerjaningsih, Nusantara, Fraser, & Aldridge, 2001; Waldrip & Fisher, 2001; Wong & Fraser, 1996; Wubbels, Brekelman, & Hooymayers, 1991; Wubbels & Levy, 1993).

Figures 6.2 and 6.3 show two profiles representing the students' perceptions of their actual and preferred teachers' interpersonal behaviour in physics classes in Thailand. Based on the information in such profiles, Thai physics teachers might decide to change the way they behave in an attempt to create a more desirable classroom environment. For example, physics teachers wanting to improve their leadership behaviours could organize professional development activities accordingly. Thus, the sector diagrams could be used a basis for discussion of teaching behaviours.

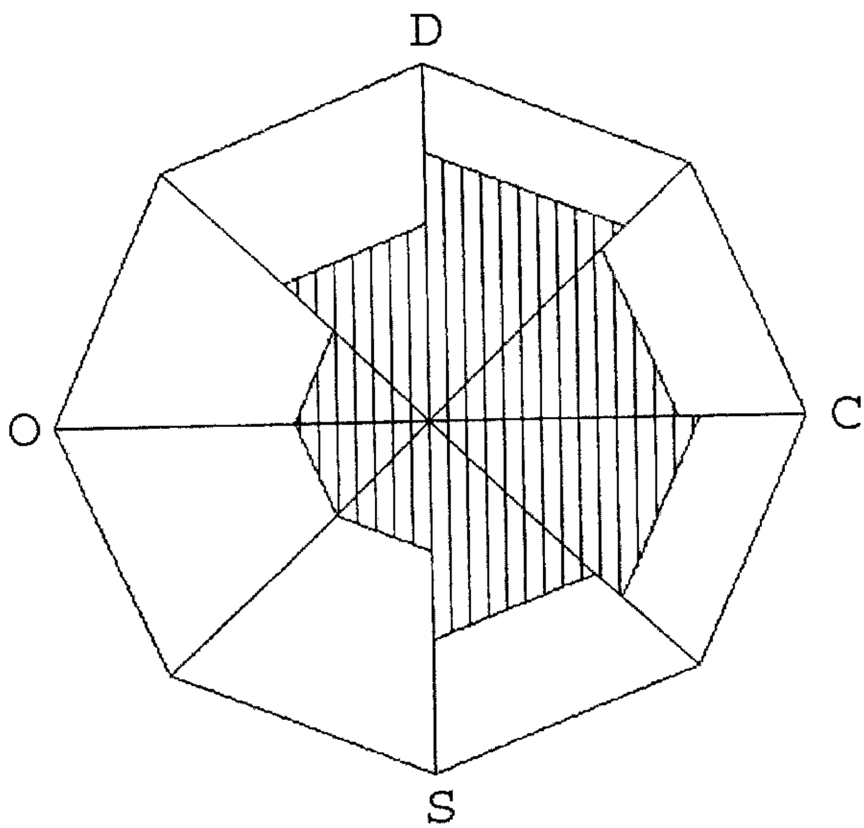


Figure 6.2. Sector profile of students' perceptions of Thai physics teachers' actual interpersonal behaviour.

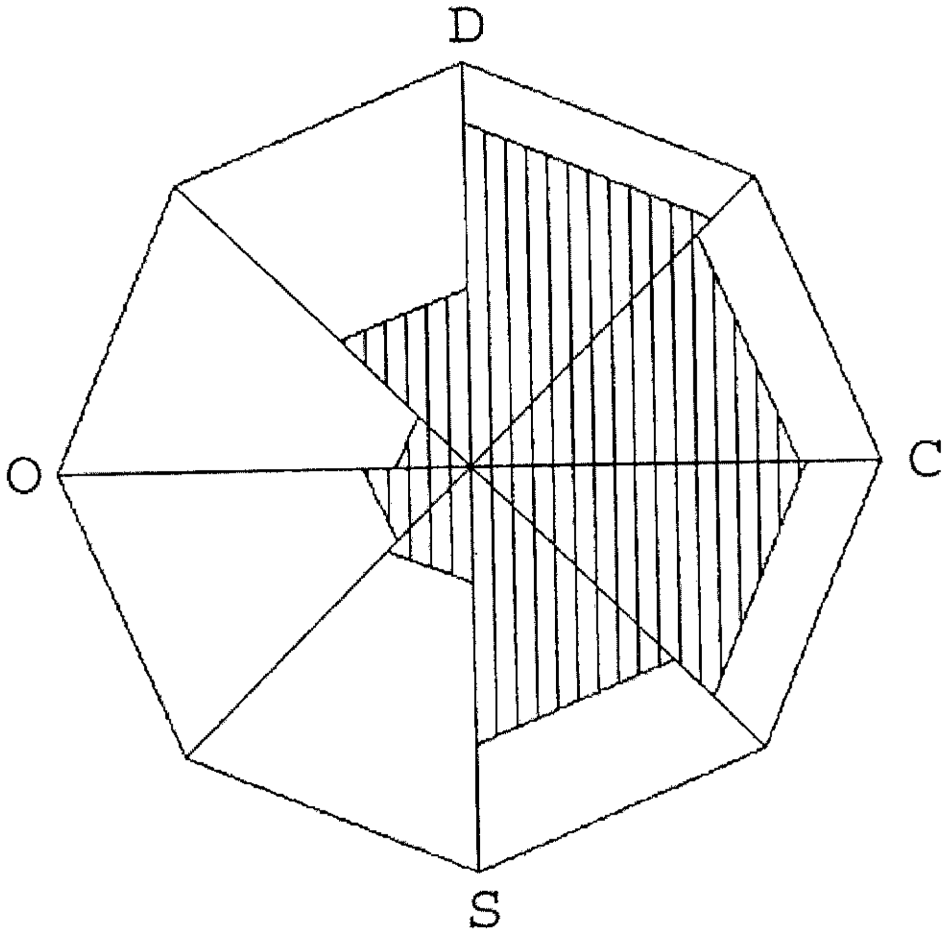
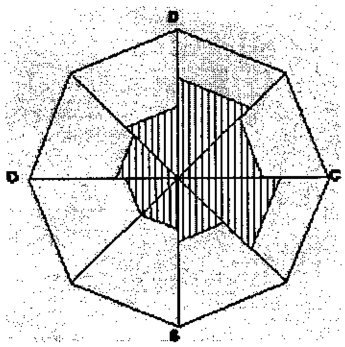
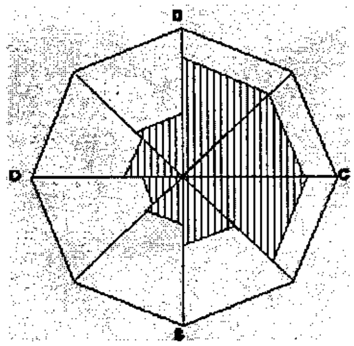


Figure 6.3. Sector profile of students' perceptions of Thai physics teachers' preferred interpersonal behaviour.

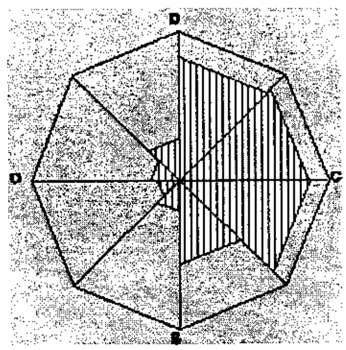
A visual comparison of the results from this study of students' perceptions of in the physics teachers in Thailand with students' perceptions of science teachers in The Netherlands (see Figure 6.4) and Australian (Brekelmans, Levy, & Rodringuez, 1993) (see Figure 6.5) indicates that Thai physics teachers could be classified as Authoritative.



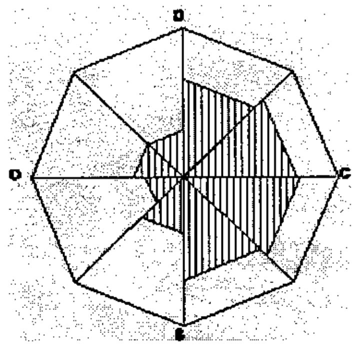
Type 1 Directive



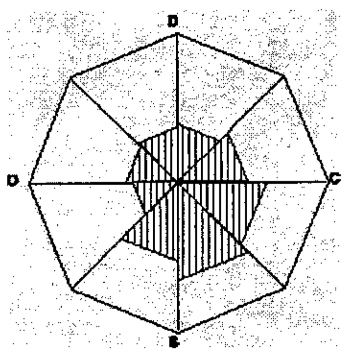
Type 2 Authoritative



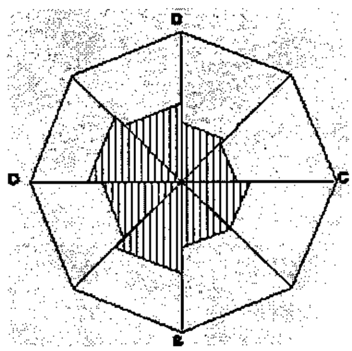
Type 3 Tolerant and authoritative



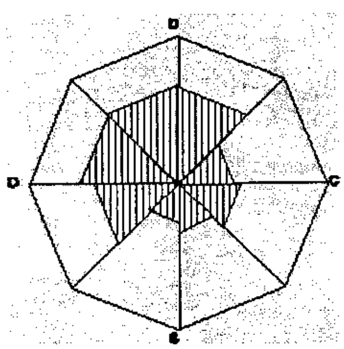
Type 4 Tolerant



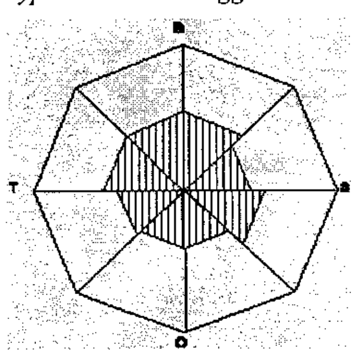
Type 5 Uncertain/tolerant



Type 6 Uncertain/aggressive



Type 7 Regressive



Type 8 Drudging

Figure 6.4. Graphical depiction of the sample cluster solution in terms of the eight QTI scales (Brekelmans, Levy, & Rodringuez, 1993, p. 38).

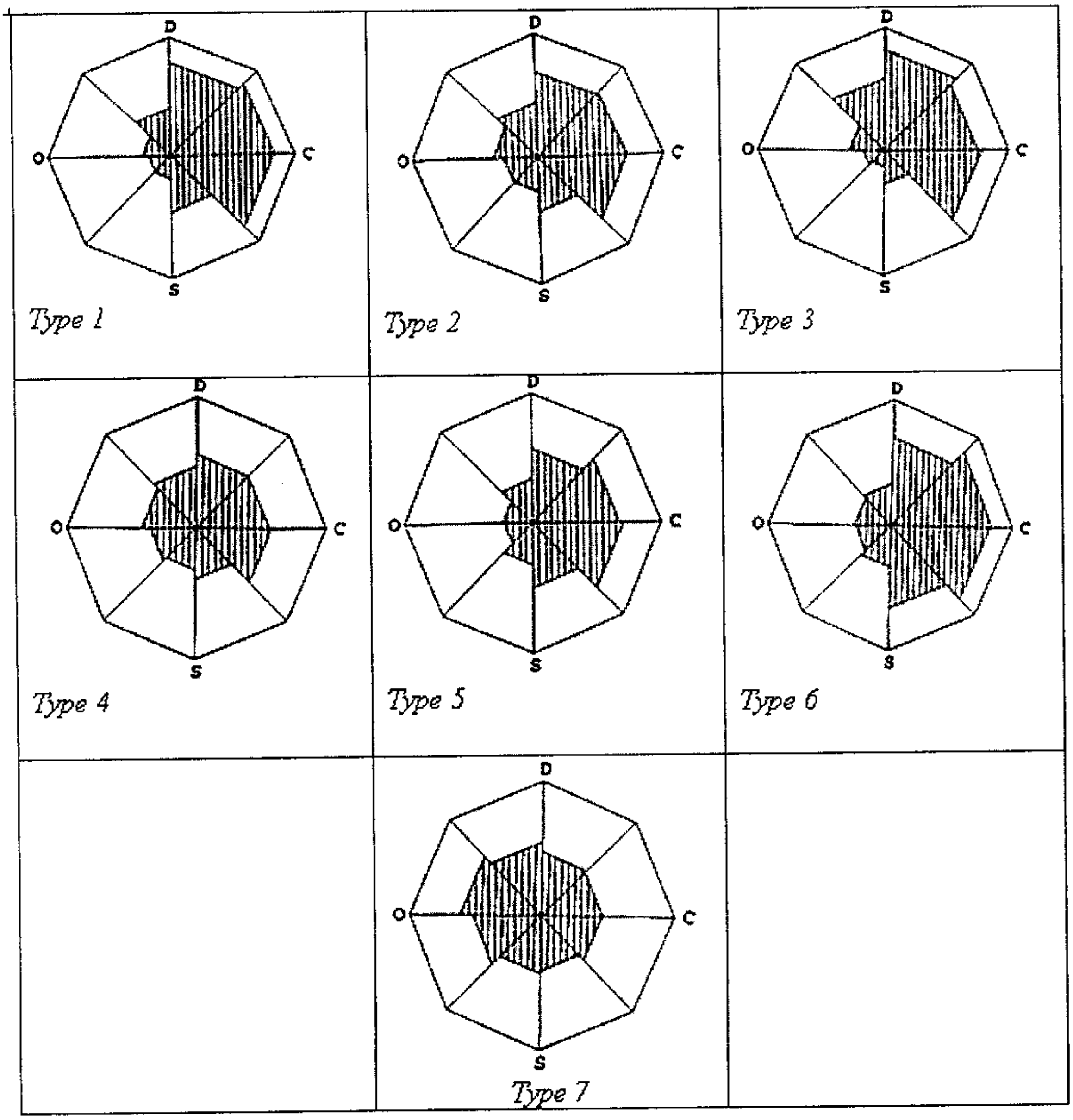


Figure 6.5. Graphical depiction of the sample cluster solution in terms of the eight QTI scales of Australian Typology (Rickards, den Brok, & Fisher, 2003).

Authoritative teachers were described by Brekelmans, Levy and Rodringuez (1993, p. 49) as:

> The Authoritative atmosphere is well-structured, pleasant and task-oriented. Rules and procedures are clear and students don't need to be reminded. They are attentive, and generally produce better work than their peers in the Directive teacher's classes. The Authoritative teacher is enthusiastic and open to students' needs. S/he takes a personal interest in them, and this comes through in the lessons.

While his/her favourite method is the lecture, the authoritative teacher frequently uses other techniques. The lessons are well planned and logically structured.

6.3 STUDENTS' PERCEPTIONS OF THEIR ACTUAL AND PREFERRED CLASSROOM LABORATORY ENVIRONMENTS

The actual and preferred perceptions of 4,576 students of their physics laboratory classroom environments were also measured using the PLEI. The PLEI data for the 245 physics school classes were used to generate for each PLEI scale: the class mean of students' actual and preferred scores, the standard deviations and the *t*-test results for statistical significance.

The scale means ranged from 20.76 to 26.43 on the Actual Form, and from 24.37 to 28.14 on the Preferred Form (maximum 35, minimum 7). Standard deviations for the Actual Form ranged from 2.96 on the Open-Endedness scale to 3.63 on the Student Cohesiveness, where as on the Preferred Form, standard deviations ranged from 3.48 on the Open-Endedness scale to 3.91 on the Student Cohesiveness, Rule Clarity, and Material Environment scales. The mean differences between the students' responses to the Actual and Preferred Forms ranged from 1.17 (preferred-actual) on the Student Cohesiveness scale to 4.66 on the Material Environment scale. Table 5.2 reveals that the differences between the Actual and Preferred Forms of the PLEI scales were statistically significant at the 0.01 level for all of the five scales.

Table 6.2
Scale Means, Standard Deviations and Mean Differences for Actual and Preferred Forms of the PLEI

Scale	Mean		Standard Deviations		Mean Diff.	*t*-value
	Actual	Pref.	Actual	Pref.		
Student Cohesiveness	26.43	28.14	3.63	3.91	1.17*	21.06***
Open-Endedness	20.76	24.37	2.96	3.48	3.61*	43.54***
Integration	24.63	27.24	3.51	3.89	2.60*	31.52***
Rule Clarity	23.68	28.14	3.37	3.91	3.45*	42.37***
Material Environment	22.75	27.40	3.24	3.91	4.66*	52.92***

*n = 4,576, *p<0.05, **p< 0.01, ***p< 0.001*

Figure 6.6 illustrates the differences between the Actual and Preferred Forms and indicates that students would prefer more student cohesiveness, open-endedness, integration, rule clarity and an enhanced material environment in their laboratories. In general, students' perceptions of their preferred classroom laboratory environment in physics classes tended to be greater than what their actually perceive to be present. This finding supports previous related research in science laboratory learning environments (Fraser, Giddings & McRobbie 1992, Henderson, Fisher & Fraser 1995, Lawrenz 1987, Rickards & Fisher 1997, Wong & Fraser 1997). The results of this study also indicate that using the PLEI helps Thai physics teachers to gain a better picture of the learning environment and the perceived learning needs of their students. It also provides support for the idea that teachers needed to take differences into consideration when planning and designing the physics curriculum for the students in the physics laboratory environments.

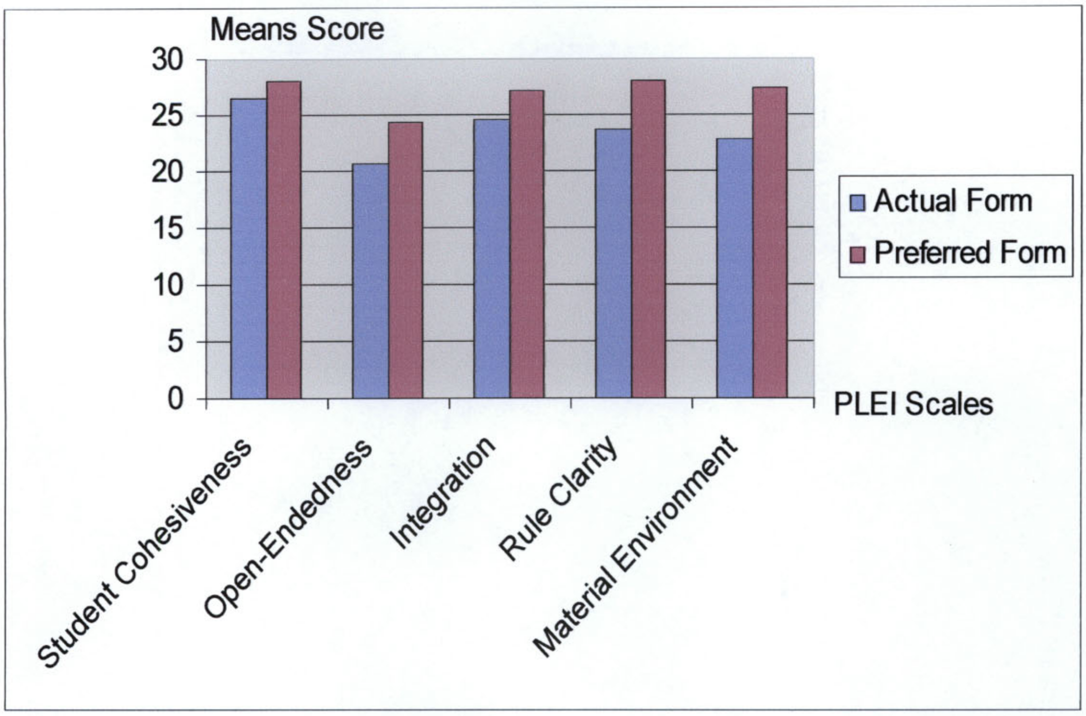


Figure 6.6. Significant differences between students' perceptions of their actual and preferred scores on the PLEI.

6.4 ASSOCIATIONS BETWEEN STUDENTS' PERCEPTIONS OF TEACHERS' INTERPERSONAL BEHAVIOUR AND LABORATORY LEARNING ENVIRONMENT WITH ATTITUDES

There have been a number of studies that have investigated associations between the classroom learning environment and student outcomes (achievement and attitudes) in countries throughout Asia: including Indonesia (Fraser, Pearse, & Azmi, 1982; Schibeci, Rideng, & Fraser, 1987); India (Walberg, Singh, & Rasher, 1977; Koul & Fisher, 2002); Singapore (Fraser & Chionh, 2000); Taiwan (Aldridge & Fraser, 1999) and Brunei (Riah & Fraser, 1998). Each of these studies has suggested that the psychosocial climate of classrooms is an important determinant of student outcomes.

In this study, it was also considered important to investigate associations between students' perceptions of their teachers' interpersonal behaviour and their physics laboratory classroom environments with their attitude toward physics. The selection of an evaluation and assessment instrument suitable for answering the sixth and seventh research questions was required. The internal consistency (Cronbach alpha reliability) of the selected Attitude scale was 0.69, when using individual student as the unit of analysis. This suggests that the scale is reliable for measuring students' attitudes in physics classes.

Table 6.3
Associations between QTI Scales and Attitudes to Physics Classes in Terms of Simple and Multiple Correlations (R) and Standardized Regression Coefficient (β)

Scale	Simple Correlation Attitude *(r)*	Standardized Regression Weight Attitude *(β)*
Leadership	0.16**	0.13**
Helping/Friendly	0.18**	0.15**
Understanding	0.15**	0.12**
Student Responsibility/Freedom	0.02	0.12**
Uncertain	-0.15**	-0.18**
Dissatisfied	-0.17**	-0.16**
Admonishing	-0.14**	-0.11**
Strict	0.13**	0.12**
Multiple Correlation *(R)*	0.73*	
R^2	0.54	

n = 4,576, *$p<0.05$, **$p<0.01$

Two main methods of data analysis were used to investigate this environment-attitude relationship. These involved: simple correlational analyses of relationships between students' perceptions of both their actual teachers' interpersonal behaviour and their actual physics laboratory classroom environments with their attitude toward physics; and multiple regression analyses of relationships between the set of actual environment scales as a whole and the attitude scale. The summary of the results of these analyses is reported in Tables 6.3 and 6.4.

The simple correlation values (*r*) are reported in Table 6.3 which show statistically significant correlations ($p<0.01$) between students' attitudinal outcomes and teachers' interpersonal behaviour on all scales except student responsibility and freedom. These associations are positive for the scales of Leadership, Helping/Friendly, Understanding, and Strict and negative for the scales of Uncertain, Admonishing and Dissatisfied. That is, in classes where the students perceived greater leadership, helping/friendly, understanding and strict behaviours in their teachers, there was a more favourable attitude towards their physics class. The converse was true when the teachers were perceived as uncertain, admonishing and dissatisfied.

The second type of analysis consisted of the more conservative standardized regression coefficient (β) which measures the association between students' perceptions on each scale of the QTI and their attitudes towards physics when the effect of relationships between the scales is controlled for.

The multiple correlation *R* is significant for Actual Forms of the QTI and shows that when the scales are considered together there is a significant ($p<0.001$) association with the Attitude scale (see Table 6.3). The R^2 value indicates that 54% of the variance in students' attitude to their physics class was attributable to their perceptions of their teachers' interpersonal behaviour. The beta weights (β) show that in classes where the students perceived greater leadership, helping/friendly, understanding, student responsibility/freedom and strict behaviours and less uncertain, admonishing, and dissatisfied behaviours in their teachers, there was a more favourable attitude towards their physics classes.

6.5 ASSOCIATIONS BETWEEN STUDENTS' PERCEPTIONS OF THEIR PHYSICS LABORATORY CLASSROOM LEARNING ENVIRONMENT AND THEIR ATTITUDES TOWARD PHYSICS

Focusing on the PLEI, the same statistical procedures also involved the investigation of associations between students' perceptions of their actual physics classroom environments and their attitudes toward physics. The simple correlation values (*r*) are reported in Table 6.4 which shows significant correlations ($p<0.01$) between students' attitudinal outcomes and physics classroom environment on all scales. These associations are all positive. In classes where the students perceived greater student cohesiveness, open-endedness, clear rules and a satisfactory material environment there was a more favourable attitude towards their physics class.

Table 6.4
Associations between PLEI Scales and Attitude to Physics Scale in Terms of Simple and Multiple Correlations (R) and Standardized Regression Coefficient (β)

Scale	Simple Correlation Attitude *(r)*	Standardized Regression Weight Attitude *(β)*
Student Cohesiveness	0.20**	0.25**
Open-Endedness	0.19**	0.13**
Integration	0.18**	0.07
Rule Clarity	0.14**	0.17**
Material Environment	0.17**	0.23**
Multiple Correlation *(R)*		0.59*
R^2		0.35

n = 4,576, *$p<0.05$, **$p<0.01$

The second type of analysis consisted of the conservative standardized regression coefficient which measures the association between students' perceptions on each scale of the PLEI and their attitudes towards physics when the effect of relationships between the scales is controlled for.

The multiple correlation *R* is significant for the PLEI and shows that when the scales are considered together there are significant associations with the Attitude scale (see Table 6.4). The R^2 value indicates that 35% of the variance in students' attitude to their physics class was attributable to their perceptions of their physics laboratory classroom environments. The beta weights *(β)* show that in classes where the students perceived greater student cohesiveness, open-endedness, rule clarity, and material environment scales in their physics laboratory lessons, they had a more favourable attitude towards their physics classes. Overall, Thai upper secondary school students show relatively favourable perceptions of their physics laboratory classroom environments.

6.6 SUMMARY OF THE CHAPTER

The actual and preferred perceptions of 4,576 students of their teachers' interpersonal behaviour in physics classrooms were measured with the QTI. The comparisons of the Actual Form with the Preferred Form indicated that students would prefer more leadership, helping/friendly and understanding behaviours in their teachers and would prefer to be given more responsibility and freedom. However, they would prefer less uncertain, dissatisfied, admonishing and strict behaviours. In terms of the PLEI, there were differences between the Actual and Preferred Forms indicating that students would prefer more student cohesiveness, open-endedness, integration, rule clarity and an enhanced material environment in their laboratories. In general, students' perceptions of their preferred classroom laboratory environment in physics classes tended to be greater than what they actually perceive to be provided.

When comparing the sector profiles of physics teachers in Thailand with a Dutch and Australian QTI-based typology, Thai teachers could be described as authoritative. Furthermore, Thai students would prefer authoritative teachers.

An investigation of the association between students' perceptions of teachers' interpersonal behaviour and learning environments with their attitudes to their physics classes was carried out. Four of the eight QTI scales, namely, Leadership, Helping/Friendly, Understanding and Strict were found to have a consistent positive relationship with the Attitude scale. However, the Uncertain, Dissatisfied, and Admonishing scales had a negative relationship with the Attitude scale.

With regard to the PLEI, it was found that four of five scales, Student Cohesiveness, Open-Endedness, Rule Clarity, and Material Environment were positively associated with students' attitude to physics class.

The results presented in this chapter have provided answers to Research Questions 3 to 6. The following chapter provides the results obtained to answer Research Question 7.

CHAPTER 7

STUDENT OPINION

7.1 INTRODUCTION

This chapter presents the results obtained in the study to answer Research Question 7. To collect qualitative and quantitative data, student interviews were used. The sub-sample was intended to be about 5% (200 students) of a sample of 4,576 of physics students in upper secondary school classes for interviews.

Educational researchers claim that there is merit in including both quantitative and qualitative methods within the same research study on classroom learning environments (Tobin & Fraser, 1998). In this study, qualitative methods involved interviews with students. A distinctive feature of this study was that the quantitative information from questionnaires assessing students' opinions of physics classroom psychosocial environment was complemented by quantitative information from interviews.

7.2 RESULTS FROM INTERVIEWS

In this study, 200 students (about 5% of 4,576 students) was the sample selected for interviews. Four students from each of 50 classes were selected for face-to-face interviews. Usually, the students were interviewed in groups of four and occasionally in pairs. During the interviews, the students were asked for their answers to the 16 questions shown in Table 7.1. They were allowed to have different opinions and researcher recorded their responses. Following the interviews, the students' comments and opinions were considered and particular categories of comments could be identified. The responses were then grouped in these categories, and finally translated into English. Table 7.1 presents the percentages of students' opinions according to these categorises. Other additional information, such as gender and age was gathered during the interviews to provide a picture of physics classes in Thailand. Thus, the interviews provided a more comprehensive picture of physics laboratory classroom environments in Thailand.

Table 7.1
Categories of Responses from Interviews

	Interview Questions	Categories	Percentage
1.	Sex	Male	40.1
		Female	59.9
2.	How old are you?	15	0.5
		16	4.2
		17	35.1
		18	54.6
		19	4.2
		20	0.8
		21	0.1
3.	What grade did you get in physics in the last semester?	0 level (E)	8.8
		1 level (D)	34.0
		2 level (C)	25.3
		3 level (B)	23.4
		4 level (A)	8.5
4.	What do you think about your physics teachers' behaviour?	Manages classroom procedures	9.5
		Behaves in a friendly way	35.5
		Shows confidence when dealing with students	7.8
		Gives freedom to the students	11.5
		Keeps a low profile	8.4
		Looks unhappy	5.7
		Sometimes gets angry	6.7
		Strictly enforces the rules	15.3
5.	Do you like your teacher's style of teaching?	Yes	35.1
		No	64.8

6.	What do you think of your physics classroom environment?	Provides help and support	24.8
		Allows for open-ended experiments	14.4
		The activities are integrated	20.4
		Strongly guided by formal rules	27.9
		An adequate material perfectly	12.5
7.	Would you like to do experimental work in your physics laboratory classes?	Yes	29.6
		No	70.4
8.	Are you enjoying working with your friends in your classroom?	Yes	40.5
		No	59.5
9.	What is the most interesting subject for you?	Biology	35.5
		Chemistry	12.5
		Physics	14.1
		Mathematics	17.0
		Some other subjects	21.9
10.	What do you think is the most difficult subject in science?	Biology	11.9
		Chemistry	32.3
		Physics	55.8
11.	What do you think is the easiest subject in science?	Biology	69.3
		Chemistry	13.4
		Physics	14.3

12.	What fields are you likely to study in the future?	Biology	30.3
		Chemistry	10.3
		Physics	13.4
		Mathematics	10.1
		Some other subjects	35.9
13.	For how many years have you had experience in physics?	0 year	0.0
		1 year	0.5
		2 year	84.1
		3 year	14.4
		4 year	0.7
		more than 4 years	0.3
14.	Do you know the meaning of the word physics?	Yes	70.4
		No	29.6
15.	What do you do to enhance and improve your learning in physics?	Study by himself/herself	21.2
		Extra learning from the tutor in the institute	23.8
		Parents give support	4.7
		Only interested in what I get from teacher in class	40.9
		Others	9.3
16.	What are the factors, in your opinion, that causes the average score in physics to be the lowest of all subjects?	The teacher	37.0
		Laboratory experimental work	22.5
		Inadequate material and equipment	26.3
		The problem is with students	13.7
		Others	0.5

Table 7.1 shows that 59.9% of the sample was female. This percentage is quite high as females are generally in a minority in western countries. The average age of students was 17.6 years old, the students' grade levels were low with 42.8% receiving D or E grades.

As expected, most of the students thought that their physics teachers behaved in a friendly way (35.2%) and strictly enforced the rules (15.3%). Students made comments about the positive relationship with the teachers who were enthusiastic about their physics laboratory classes and or demonstrated high levels of helping and friendly behaviour. They also indicated their willingness to accept high levels of strict behaviour. The students that were interviewed supported what had been discovered with the use of the QTI where the means for the Helping/Friendly and Strict scales were 16.08 and 13.30, respectively.

Generally, students did not like their teachers' style of teaching (64.7%). In terms of the physics classroom environment, most of them thought that the laboratory environment was dominated by the formal rules they had to obey (27.9%). Almost 25% of the students thought that the environment was supportive and about 20% thought their laboratory work was integrated with their theory class. A significant number, 12.5% of the sample thought that the material equipment and instruments were not perfect.

The strong influence of rules was also shown in the results of the PLEI where the mean for the Rule Clarity was 23.68. The provision of help and support could well be from one another student as the mean for Student Cohesiveness was 26.43.

About 70% of the students did not like the physics laboratory and did not enjoy working with their friends (59.5%) and 55.8% thought that physics was the most difficult subject in science and the least interesting. However, 70.4% knew the meaning of physics and 84.1% had experience in physics over two years. A large percentage (40.9%) of the sample did not plan to study physics in the future.

In term of students' opinions about what causes the average score in physics to be the lowest of all subjects, students thought that the main reasons were the teacher (37%) and inadequate material and equipment (26%).

The qualitative data were consistent and supported the views expressed through the QTI and PLEI. Students commented during interviews that their teachers were helpful and friendly but firm. There were high scale mean scores on the QTI scale for the Helping/Friendly and Strict scales. Students also commented during interviews that the materials and equipment provided for physics were not good.

7.3 SUMMARY OF THE CHAPTER

Interviews were completed with a sub sample of 200 students; four students from each of 50 classes. The responses were grouped into categories and the percentages of students' opinions recorded. A comprehensive picture of physics laboratory classroom environments in Thailand was provided by students' interviews.

The average age was 17.6 years and the percentage of females in the sample was quite high. Students thought that they did not like their teachers' style of teaching, did not do experimental work in their physics laboratory classes and were generally unhappy about the work in their classes. Most of the students thought that biology is the most interesting, but physics is the most difficult in science.

The quantitative results obtained with the QTI and PLEI were consistently supported by the qualitative data from the interviews. For example, the students thought that their teachers were friendly as indicated on the QTI scale of Helping/Friendly. The students also commented during interviews that their classrooms were not good in terms of the material environment as reflected in this scale of the PLEI.

CHAPTER 8

CONCLUSIONS

8.1 INTRODUCTION

This chapter summarizes the thesis, describes students' perceptions of physics classroom environments in upper secondary school classes in Thailand, and considers how this can be used to improve the performance of students in physics. This study has focused on the subject of physics, the general nature of physics classroom environments, students' attitudes toward physics, and students' opinions about their physics subject and their teachers' interpersonal behaviour. Qualitative and quantitative approaches were used. Quantitative data were gathered with two instruments, namely, the Physics Learning Environment Inventory (PLEI) modified from the original Science Laboratory Environment Inventory (SLEI) (Fraser, McRobbie, & Giddings, 1993) and the Questionnaire on Teacher Interaction (QTI) (Wubbels & Levy, 1993). An Attitude Scale which was based on the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981) was also used in this study.

Also, it was considered important to investigate differences between actual and preferred students' perceptions, and associations between students' perceptions of their teachers' interpersonal behaviour and their learning environments with students' attitudes to their physics classes. The questionnaires were translated into the Thai language and administered to a sample of 4,576 students in 245 physics school classes at the grade 12 level. A sub-sample, intended to be about 5% (200 students) were selected for interviews, and were an additional source of information to guide revisions to the questionnaires used in this study.

This chapter discusses the findings of the study, which were presented in Chapters 4, 5, 6 and 7, under four main headings: (1) validation of the questionnaires; the Physics Laboratory Environment Inventory (PLEI), the Questionnaire on Teacher Interaction (QTI) and the Attitude Scale for use in Thailand; (2) actual and preferred differences between the students' perceptions of their classroom laboratory environments, and teachers' interpersonal behaviour in physics classes in Thailand;

(3) associations between students' perceptions of their physics laboratory classroom environments, and their teachers' interpersonal behaviour and their attitudes toward physics; and (4) students' opinions in the group interviews about the situation of physics having the lowest average score at the grade 12 level in Thailand. A summary of the main findings, their implications for science education, particularly physics education and recommendations for future classroom environment research in Thailand are provided in this chapter, and the chapter ends with final remarks.

8.2 VALIDATION OF QUESTIONNAIRES

This section discusses the results of the classroom learning environment instruments involved in this study; the PLEI, the QTI and the Attitude Scale. Statistical information currently available for the instruments was considered previously and this included information about each scale's internal consistency reliability (alpha coefficients), discrimunant validity (using the mean correlation of a scale with the other scales in the same instrument as a convenient index) and the ability of a scale to differentate between the perceptions of students in different classrooms.

8.2.1 Validation of the PLEI

***Research Question 1*: Is the Physics Laboratory Environment Inventory (PLEI) a valid and reliable instrument for use in Thailand?**

The reliability coefficients for the different PLEI scales ranged from 0.60 to 0.70 for the Actual Form and from 0.58 to 0.67 for the Preferred Form, when using the individual student as the unit of analysis. The discriminant validity coefficients (the mean correlation of a scale with the other scales) of the physics classroom environment ranged from 0.21 to 0.47 for the Actual Form and from 0.37 to 0.52 for the Preferred Form. The distinct nature of the scales was checked by using factor analysis; the Actual and Preferred Forms of the PLEI were subjected to separate principal components factor analyses (with varimax rotation) involving the individual student' score. The factor analyses supported the five-scale structure of the PLEI. The PLEI was also subjected to a series of one-way analyses of variance (ANOVA), where the eta^2 statistics ranged from 0.17 to 0.20 for the different scales.

It was confirmed that each scale differentiated significantly ($p<0.001$) between the perceptions of students in different classrooms.

These results suggest that the scales of the Thai version of the PLEI display satisfactory internal consistency, discriminant validity, factorial validity and differentiates significantly between the perceptions of students in different classrooms. Thus, the PLEI is a valid and reliable instrument for use in physics classrooms in Thailand.

8.2.2 Validation of the QTI

***Research Question 2*: Is the Questionnaire on Teacher Interaction (QTI) a valid and reliable instrument for use in Thailand?**

The reliability results for scales of the QTI ranged between 0.60 and 0.84, the highest alpha reliability was obtained for the scale of Dissatisfied and the lowest for the scale Student Responsibility/Freedom, when using students' actual perceptions scores and ranged from 0.57 to 0.78 when using students' preferred perceptions.

Further analyses were also completed to explore the inter-scale correlations of the QTI. The scales of the QTI are arranged to form a circular pattern or circumflex model and are expected to correlate most with adjacent scales. The results of the inter-scale correlations from this study generally reflect the circumflex nature of the QTI and further confirm the validity of the instrument. For example; the scale Leadership is correlated closely and positively with Helping/Friendly (0.58), Understanding (0.74) and Student Responsibility/Freedom (0.45), this correlation decreases with other scales highest negative correlation of (-0.46) occurring with the Admonishing scale, and with Uncertain (-0.41), Dissatisfied (-0.36) and Strict (-0.20), when using students' actual perceptions as the unit of analysis. With the Preferred Form, the scale Leadership is correlated closely and positive with Helping/Friendly (0.55), Understanding (0.73) and Student Responsibility/Freedom (0.41), and negative with Uncertain (-0.37), Dissatisfied (-0.38), Admonishing (-0.52) and Strict (-0.20).

As with the PLEI, a series of one-way ANOVA analyses suggests that each scale of the QTI is able to differentiate significantly ($p<0.001$) between students' perceptions of actual and preferred classroom environments in different school classes. The amount of variance in scores accounted for by class membership ranged from 0.25 to 0.31. It appears that the instrument is able to differentiate clearly between the perceptions of students in different classes.

Overall, these analyses have shown that the Thai version of the QTI is a reliable and valid instrument for assessing students' perceptions of their teachers' interpersonal behaviour in their physics classes and it may be used in either Actual or Preferred Forms. The results from these analyses confirmed the circumplex nature of the QTI and taken with reliability, and the ability to differentiate between classes suggest that QTI can be used as a valid and reliable instrument in Thailand.

8.2.3 Validation of the Attitude Scale

In the current study, the reliability coefficient of the Attitude Scale instrument was 0.69; this suggests that the Attitude Scale is valid for use in this study.

Thus, appropriate statistical procedures were used in order to answer the first two research questions regarding the validation of the questionnaires. The procedures included factor analysis, item analysis, Cronbach alpha, discriminant validity and one-way ANOVA. The three instruments, namely, the Physics Laboratory Environment Inventory (PLEI), the Questionnaire on Teacher Interaction (QTI) and the Attitude Scale are valid and reliable for use in Thailand's upper secondary schools.

8.3 COMPARISONS BETWEEN STUDENTS' PERCEPTIONS OF THEIR ACTUAL AND PREFERRED CLASSROOM LEARNING ENVIRONMENTS

This section summarises discusses the results of the investigation of actual and preferred differences in physics classroom environment perceptions using the QTI and the PLEI. These were determined using the mean scores, standard deviations, mean differences and comparisons of means by t-tests for paired samples. The results provide answers to Research Questions 3 and 4.

8.3.1 Students' Perceptions of their Actual and Preferred Teachers' Interpersonal Behaviour

***Research Question 3*: Are there any differences between the students' perceptions of their actual and preferred teachers' interpersonal behaviour in physics classrooms in Thailand?**

The scale means ranged from 6.25 to 18.05 on the Actual Form, and from 4.41 to 20.49 on the Preferred Form. Standard deviations for the Actual Form ranged from 3.37 on the Student Responsibility/Freedom scale to 5.21 on the Dissatisfied scale, whereas on the Preferred Form, standard deviations ranged from 2.90 on the Leadership scale to 4.21 on the Dissatisfied scale. The mean differences between the students' responses to the Actual and Preferred Forms ranged from -4.26 (preferred – actual) on the Admonishing scale to 3.27 (preferred – actual) on the Helping/Friendly scale.

The standard deviations of the students' perceptions of actual teacher behaviour are higher than the standard deviations of preferred teacher behaviour for seven of the eight scales. The presence of more variation in the majority of the actual teacher interpersonal behaviour than in the majority of the preferred teacher interpersonal behaviour may indicate that students are more agreed about preferred teacher interpersonal behaviour. These results reveal that the differences between the Actual and Preferred Forms of the QTI scales were statistically significant at the 0.01 level for all of the eight scales.

Overall, Thai upper secondary school students show relatively favourable perceptions of their teachers' interpersonal behaviour. The comparisons of the Actual Form with the Preferred Form indicated that students would prefer more leadership, helping/friendly and understanding behaviours in their teachers and would prefer to be given more responsibility and freedom. However, they would prefer less uncertain, dissatisfied, admonishing and strict behaviours. Furthermore, when comparing the sector profiles of physics teachers in Thailand with an Australian QTI-based typology, Thai teachers could be described as authoritative and Thai students would prefer authoritative teachers.

8.3.2 Students' Perceptions of their Actual and Preferred Classroom Laboratory Environments in Physics Classes in Thailand

***Research Question 4*: Are there any differences between the students' perceptions of their actual and preferred classroom laboratory environments in physics classes in Thailand?**

The scale means ranged from 20.76 to 26.43 on the Actual Form of the PLEI, and from 24.37 to 28.14 on the Preferred Form. Standard deviations for the Actual Form ranged from 2.96 on the Open-Endedness scale to 3.63 on the Student Cohesiveness scale, whereas on the Preferred Form, standard deviations ranged from 3.48 on the Open-Endedness scale to 3.91 on the Student Cohesiveness, Rule Clarity, and Material Environment scales. The mean differences between the students' responses to the Actual and Preferred Forms ranged from 1.17 (preferred–actual) on the Student Cohesiveness scale to 4.66 (preferred–actual) on the Material Environment scale. This finding revealed that the differences between the Actual and Preferred Forms of the PLEI scales were statistically significant at the 0.01 level for all of the five scales.

In terms of the PLEI, the differences between scores on the Actual and Preferred forms indicate that students would prefer more student cohesiveness, open-endedness, integration, rule clarity and an enhanced material environment in their laboratories. In general, students' perceptions of their preferred classroom laboratory environment in physics classes is greater than what they actually perceive to be provided.

8.4 ASSOCIATIONS BETWEEN STUDENTS' PERCEPTIONS OF THEIR PHYSICS CLASSROOM ENVIRONMENTS AND THEIR ATTITUDES TOWARD PHYSICS

This study attempted to identify what aspects of physics classroom learning environment influence students' attitudinal outcomes, and seen in Research Questions 5 and 6.

8.4.1 Associations between Students' Perceptions of their Teachers' Interpersonal Behaviour in Physics and their Attitudes toward Physics

This section discusses the results of the investigation of associations between students' perceptions of their teachers' interpersonal behaviour in physics and their attitudes toward physics. Specifically, the fifth research question was:

***Research Question 5*: What associations are there between students' perceptions of their teachers' interpersonal behaviour in physics and their attitudes toward physics?**

Associations between students' perceptions of their teachers' interpersonal behaviour in physics and their attitudes toward physics were explored using simple and multiple correlation analyses.

The simple correlation between students' perceptions of their teachers' interpersonal behaviour in physics and their attitudes toward physics for all scales of the QTI were statistically significant ($p<0.01$) for the Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, and Strict scales while for the Uncertain, Admonishing and Dissatisfied behaviours they were statistically negatively significant.

The more conservative standardized regression coefficient (β) which measures the association between students' perceptions on each scale of the QTI and their attitudes towards physics, when the effect of relationships between the scales is controlled was also obtained. The multiple correlation R was significant for the Actual Form of the

QTI and shows that when the scales are considered together there is a significant ($p<0.01$) association with the Attitude scale. The R^2 value indicated that 54% of the variance in students' attitude to their physics class was attributable to their perceptions of their teachers' interpersonal behaviour. The beta weights (β) showed that in classes where the students perceived greater leadership, helping/friendly, understanding, student responsibility/freedom and strict behaviours and less uncertain, admonishing, and dissatisfied behaviours in their teachers, there was a more favourable attitude towards their physics classes.

Thus, five of the eight QTI scales, namely, Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom and Strict were found to have a strong, consistent and positive relationship with the attitude scale. However, the Uncertain, Dissatisfied, and Admonishing scales had a negative relationship with the attitude scale.

8.4.2 Associations between Students' Perceptions of their Physics Laboratory Classroom Environments and their Attitudes toward Physics

This section discusses the results of the investigation of associations between students' perceptions of their physics laboratory classroom environments and their attitudes toward physics. The same statistical analyses as used with the QTI were again employed. Specifically, the sixth research question was:

***Research Question 6*: What associations are there between students' perceptions of their physics classroom environments and their attitudes toward physics?**

The results of the simple correlation analysis indicate that the four scales of Student Cohesiveness, Open-Endedness, Rule Clarity and Material Environment were also associated significantly with the Attitude scale ($p<0.01$) and and these associations were positive. The multiple correlation R was significant for the PLEI and shows that when the scales are considered together there are significant associations with the Attitude scale. The R^2 value indicated that 35% of the variance in students' attitude to their physics class was attributable to their perceptions of their physics laboratory classroom environments. The beta weights (β) showed that in classes where the students perceived greater student cohesiveness, open-endedness, rule clarity, and a good material environment, they had a more favourable attitude towards their physics classes. Overall, Thai upper secondary school students show relatively favourable perceptions of their physics laboratory classroom environments.

8.5 STUDENTS' OPINIONS ABOUT THE SITUATION OF PHYSICS HAVING THE LOWEST AVERAGE SCORE AT THE GRADE 12 LEVEL IN THAILAND

Part of this research study investigated this major problem in Thai education and to gather students' opinions as to whether, the problem related to the classroom environment, teacher-student interactions, laboratory climate, curriculum framework, student dissatisfication with content, or communication of teachers when teaching. Whilst considerable research has been conducted on students' interviews of classroom learning environments, relatively little has been done to help teachers to improve the environment of their own classrooms.

The sub-sample for interviews was intended to be about 5% (200 students) of a sample of 4,576 of physics students in upper secondary school classes for interviews. Four students from each of 50 classes were selected for face-to-face interviews. Usually, the students were interviewed in groups of four and occasionally in pairs. During the interviews, the students were asked for their answers to 16 questions. They were allowed to have different opinions and researcher recorded their responses. Following the interviews, the students' comments and opinions were considered and particular categories of comments could be identified. The responses were then grouped in these categories, and finally translated into English. The results presented the percentages of students' opinions according to these categories. Other additional information, such as gender and age was gathered during the interviews to provide a picture of physics laboratory classes in Thailand. Specifically, the seventh research question was as follow:

***Research Question 7*: What are the students' opinions about the situation of physics having the lowest score at the grade 12 levels in Thailand?**

The results from interviews indicated that 59.9% of the sample was female which was surprisingly high. The average age of students was 17.6 years old; the students' grade levels were low with 42.8% receiving D or E grades.

As expected, most of the students thought that their physics teachers behaved in a friendly way (35.2%) and strictly enforced the rules (15.3%). Students made comments about positive relationships with the teachers who were enthusiastic about their physics laboratory classes and/or demonstrated high levels of helping and friendly behaviour. They also indicated their willingness to accept high levels of strict behaviour. The students that were interviewed supported what had been discovered with the use of the QTI where the means for the Helping/Friendly and Strict scales were 16.08% and 13.3%, respectively.

Generally, students did not like their teachers' style of teaching (64.7%). In terms of the physics classroom environment, most of them thought that the laboratory environment was dominated by the formal rules they had to obey (27.9%). Almost 25% of the students thought that the environment was supportive and about 20% thought their laboratory work was integrated with their theory class. A significant number, 12.5% of the sample thought that the material equipment and instruments were not perfect.

The strong influence of rules was also shown in the results of the PLEI where the mean for the Rule Clarity was 27.9%. Provision of help and support could well be from one another as the mean for Student Cohesiveness was 24.8%.

However, 70.4% of students did not like the physics laboratory and did not enjoy working with their friends (59.5%) and 55.8% thought that physics was the most difficult subject in science and the least interesting, while 70.4% knew the meaning of physics and 84.1% had experience in physics for three years. There were 40.9% of the sample who did not plan to study physics but needed to study in another field.

8.6 LIMITATIONS OF THE STUDY

This study has limitations and therefore its findings should be generalized with caution. The limitations of the study include the following: First, although the instruments were adapted to suit the context of the study, they were originally developed for students in Western countries. Therefore, interpretations of some items by students in Thailand might not necessarily be similar to interpretations by students in Western countries. The reason for these differences could be Thailand has a highly centralized education system and a different culture from that of Western countries.

Second, although the sample represented 10% of the total school classes, and 6% of the whole population of students talking physics in Thailand, the findings might not be applicable to all groups of students. The findings cannot be generalized to other groups in government schools, private schools, religious affairs schools and demonstration schools of the universities, which are under the Ministry of Education of Thailand.

8.7 IMPLICATIONS FOR IMPROVING PHYSICS EDUCATION IN THAILAND

This study has implications for physics teachers, educators, the Institute for Promotion of Teaching Science and Technology (IPST), the administrators, and educational researchers in Thailand. Five generally applicable instruments were used: the Physics Laboratory Environment Inventory (PLEI), the Questionnaire on Teacher Interaction (QTI), and the Attitude Scale, and were found valid and reliable for use in Thailand's upper secondary schools. The availability of these instruments provides a means by which students' perceptions can be monitored by teachers to attempt to improve their classroom teaching practice; they can be used by IPST staff to assist in the development of a physics curriculum at the upper secondary school level, and to monitor reviews of the administration of systematic educational reforms.

Based on the findings, suggestions for improving the physics laboratory classroom environment are needed. The physics laboratory environment is characterized by moderate level of student cohesiveness and low levels of open-endedness, integration, rule clarity and material environment. Teachers should provide laboratory activities that promote class cohesion, provide physics practical activities related to what students learn in theory classes, preview and connect to future classes, make a clearly organized plan for teaching, give definitions for vocabulary in physics content, and vary the rate of delivery where appropriate. Teachers should change and use more effective body movements and gestures to demonstrate support for their students, give sufficient variety in supporting information, promote higher order thinking, and give feedback that is informative and incorporates student responses.

Although Thailand's physics teachers' interpersonal behaviours were perceived by students as favourable, evidence from research on teacher-student relationships indicated widely differing students' perceptions of their actual and preferred teacher interpersonal behaviors in physics classes. Students preferred their teachers to exhibit more positive leadership, helping/friendly, understanding, and student responsibility/freedom behaviours; and less of the negative teacher interpersonal behaviours: uncertain, dissatisfied, admonishing and strict behaviours. However, the teachers' interpersonal behaviours showed a gap between the actual and preferred teachers' interpersonal behaviour in all of the behaviours measured. Therefore, it is important for teachers to improve their interpersonal behaviour towards students so that this gap between students' actual and preferred teacher interpersonal behaviour will decrease. Thus, physics teachers should develop the learning and teaching activities in physics classes that will enable them to exhibit more cooperative behaviour and less oppositional behaviour.

This study indicates that most dimensions of physics laboratory classroom environments were associated with students' attitudes toward physics. Positive associations were found between the scales of Student Cohesiveness, Open-Endedness, Rule Clarity and Material Environment with students' attitudes to physics classes. Physics teachers who have control of their class should be flexible enough to enable their students to be actively involved in classroom learning.

The teachers were not good on relating ideas to prior knowledge, and were not clear and specific in the use of laboratory equipment. It is suggested that classroom environment ideas and practical learning techniques could be incorporated into inservice and preservice courses for physics teachers in Thailand.

8.8 SUGGESTIONS FOR FUTURE RESEARCH IN THAILAND

Classroom environment research in Thailand is one of the reforms the Thai government has been providing in accordance with the Ninth National Education Development Plan (2002-2006). Most of the teachers who are teaching in primary and secondary education could improve their teaching by using the findings of classroom environment research. This present study is one of the first learning environment studies in Thailand involving two separate measures, the Physics Laboratory Environment Inventory (PLEI) and the Questionnaire on Teacher Interaction (QTI), as well as the Attitude Scale, and students' interviews. These instruments have been shown to be reliable and valid for use in future studies in Thailand. By using these instruments, a number of classroom environment research studies can be pursued in Thailand.

The present research involved physics students in upper secondary schools; it could be replicated in different subjects and different grade levels in government schools, private schools, religious affairs schools and demonstration schools of the university. Such studies would provide information enabling a more comprehensive view of classroom environment in schools of Thailand.

8.9 FINAL REMARKS

This study is very important because it is one of only a handful of studies in the field of learning environments in Thailand, and it represents one of only a few studies worldwide that has focused on the learning environment at the upper secondary school level in physics school classes. Overall, the findings of the present study have made several distinctive contributions to the field of learning environments that were two of the first learning environment studies to be carried out in Thailand.

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APPENDIX A

THAILAND EDUCATION SYSTEM

For education in a school-related system, it is provided by educational institutes, characterized by a class system, and the use of curriculum specified for the level and type of education so as to develop learners in accordance with curriculum object. On the other hand, education from way-of-life learning process is self-learning from various sources of knowledge and environment related to the ways of life naturally existing or modified to enhance and service learning.

Education in a school-related system is divided into four levels: pre-school education, primary education, secondary education and higher education.

1. **Pre-School Education** is in the form of childcare and readiness development of children in physical, psychological, mental, emotional, personality, and social aspects so as to prepare them for higher levels of education. The provision of education at this level can be organized in the forms of daycare center, kindergarten, or child development center, depending upon local conditions and target groups
2. **Primary Education** aims to provide a basis for learners to retain literacy and arithmetic ability to form desirable character and encompass morality, ethics, basic knowledge and target ability.
3. **Secondary Education** is divided into two parts, i.e., lower secondary and upper secondary education.

- **Lower Secondary Education** aims to promote learners' morality, knowledge, ability and skills beyond the primary level; to enable them to identify their needs and interests and to be aware of their aptitude both in general and vocational education; and to develop their ability for work and occupational practices relevant to their age.
- **Upper Secondary Education** aims to enable learners to progress according to their aptitudes and interests and acquire the basis either for furthering to higher education or for working and pursuing a career suitable for their

aptitude both as entrepreneurs and paid workers; to promote their morality, ethics, and social skills necessary for working pursuing, a career and leading peaceful social lives.

4. **Higher Education** is divided into 3 levels, i.e., lower than bachelor's degree level, bachelor's degree level, and graduate level.

- Lower Than Bachelor's Degree Level aims to promote learners' knowledge and vocational skill level including their ability to initiate jobs and develop entrepreneurship.
- **Bachelor's Degree Level** aims to promote learners' higher level of knowledge and vocational skills in various disciplines, especially ability to apply theories to practices for both academic and professional development, to create and disseminate knowledge, to participate in national development in elation to economic, social, political, cultural and environmental aspects, and to promote the role of the nation in the world community.
- **Graduate Level** aims to promote learners' specialized knowledge and skills; to strive for academic progress and excellence, especially in studies, research and development of knowledge and technology in science, humanities and social science; and to facilitate the adoption of modern technology and local Thai wisdom for economic and social development instrumental to Thai society. In addition, education in a school-related system is provided for specific needs and target groups, some of which are:
- **Teacher Education** aims to train and develop prospective as well as practicing teachers who have acquired morality, knowledge, ability and skills in teaching and motivating learner to learn; to be mindful of professionalism, spirit and responsibility of teachers; to serve as a role model for learners regarding social behaviour, life style and preservation of the national language and culture; to develop an inquiring mind and engage in continuous improvement of themselves and their teaching capability; and to engage in community development, as well as in rehabilitation, conservation and enrichment of local and national environment and culture.

- **Vocational Education** aims to enable learners to develop vocational knowledge and skills useful for working both as entrepreneurs and as paid workers; and to make decent living.

  Vocational education can be organized in both formal and non-formal systems. Vocational education in the formal school system is a development of occupational knowledge and skills relevant to each level of education from primary to higher levels. It also includes development vocational education in the non-formal system is short-course training in specific occupations for those needing to upgrade their knowledge and skills of specific vocational skills and expertise which require a long period of training from childhood, such as dancing, music and sports. Such education can be provided in special institutes created for the purpose or incorporated in the general curricula.

- **Special Education** aims to enable learners who are physically, mentally, psychologically, and emotionally handicapped to undertake learning suitable for their conditions and capability. On the other hand, it enables geniuses or talented learners to develop their aptitude to the fullest potential and maximize their ingenuity. Special education can be provided in special institutes or in general educational institutes from pre-school to higher education levels.

APPENDIX B

THAILAND'S EDUCATION ADMINISTRATION

Ministry of Education

Ministry of Education is responsible for all other primary institutes. The Ministry of Education is also responsible for overseeing the nation's secondary schooling (including teacher education and vocational training up to a tertiary level) non-formal education, as well as matters relating to religion and culture.

The Ministry of University Affairs established in 1973 oversees public and private universities and institutions of higher learning.

For special needs, education is organized by various agencies and responsible agencies have developed their own curricula which can be classified into four groups:

- Curricula for professional soldiers and police: Curricula of the military, naval, air force and police cadet require 4 years of study after 2 years in Preparatory School for the Armed Forces Academics and Grade 10.
- Curricula for specific technicians: These curricula include training military technicians to work in the armed forces and specific technicians for various agencies such as irrigation College, Railway Technical School, etc.
- Medical sciences curricula: It is 4-year study for secondary school graduates to study in the institutions of the Ministry of Public Health, Bangkok Metropolitan Administration and the Thai Red Cross Society.
- Curricula for other specific purposes: These types of curricula were designed for graduates from upper secondary school, both in general and vocational stream, as required by each institution, such as the Merchant Marine Training Center, Cooperatives School, Postal School and Civil Aviation Training Center, etc.

There are also two Buddhist Universities, Mahamakut Buddhist University and Mahachulalongkorn Buddhist University which are specifically for higher religious studies by members of the Buddhist monkhood.

▪ Thailand's Education Administration and System

.The educational system according to the National Scheme of Education of 1992 is designed to assure continuous and lifelong learning for individuals so as to promote their wisdom, spiritual, physical and social development, and their contribution toward the progress of the nation under the democratic government with the King as Head of State.

It provides an opportunity for individuals, development according to their ages and offers continuous and life-long learning, employing various forms of education, both in a school-related system of education and through the learning process from the ways of life.

▪ Thailand's Education Administration

Education in Thailand is administered by various government ministries

Administration of Education in Thailand

	Courses Offered					
Responsible Bodies	**Primary**	**Lower Secondary**	**Upper Secondary**	**Diploma / Certificate**	**Bachelor's Degree**	**Graduate Degree / Specific Certificate**
1. Ministry of Education						
1.1 Office of National Primary Education Commission (ONPEC)	*	*				
1.2 Department of General Education	*	*	*			
1.3 Office of Rajabhat Institutes Council	*	*	*		*	
1.4 Office of the Private Education Commission	*	*	*	*		
1.5 Department of Physical Education	*	*	*	*	*	
1.6 Department of Fine Arts		*	*	*	*	
1.7 Department of Vocational Education				*	*	
1.8 Department of Religious Affairs					*	*
1.9 Rajamanagala Institute of Technology				*	*	*
2. Ministry of University Affairs						
2.1 Demonstration Schools	*	*	*			
2.2 Public Institutions of Higher Education				*	*	*
2.3 Private Institutions of Higher Education					*	*
3. Ministry of Interior						
3.1 Bureau of Local Education Administration	*	*				
3.2 Bangkok Metropolitan Administration	*	*		*	*	
3.3 Department of Police	*					

APPENDIX C
Sample of 245 Physics School Classes

Educa-tional Regions	Province	Name of upper secondary school classes of sample		
		A large city school	A district-based middle school	A sub district-based small school
1.	1.Nakhon Pathom	Prapathom Wittayalai	King College School	Sirindhornraja Wittayalai
	2. Nonthaburi	Satri Nonthaburi	Sriboonyanon	Pakgrate
	3. Pathumthai	Pathumwilai	Tunyaburi	Kanarajbumrung Pathumthani
	4. Samut Prakan	Satri Samut Prakan	Wat Songthum	Bangbo Wittayakom
	5. Samut Sakhon	Samut Sakhon Wittayalai	Samut Sakhon Burana	Omnoi Sophon Uppathum
2.	6. Yala	Kanaraja Bumrung	Satri Yala	Ramun Siriwit
	7. Narathiwat	Nasa Sikkalai	Takbai	Srivarint
	8. Pattani	Benjama Rachutit	Rajamuni Rungsarit	Maikaen Kittiwit
	9. Satun	Satun Wittaya	Juraporn Raja Wittayalai	Palm Pattawit
3.	10.Songkhla	Hadyai Wittalai	Woranari Chalerm	Nathawi Wittaya
	11. Chumphon	Sriyapai	Saunsri Wittaya	Pateiw Wittaya
	12. Nakhonsri Thummarat	Kullayani Srithummatiraj	Sichol Kunatan Wittya	Changklang Prachanukul
	13.Phattalung	Phattalung	Phattalung Pittayakom	Pakpayoon Pittayakan
	14. Surat Thani	Surat Thani	Khor Samui	Muttayom Phattara Kittiyapa 3
4.	15. Phuket	Satri Phuket	Muang Thalang	Chalermprakeit Somdej Prasrinakarin
	16. Krabi	Ummart Panitchakul	Muang Krabi	Ouw Louk Prachasun

	17. Trang	Sapa Rajchini	Hui Yod	Hadsomran Wittayakom
	18. Phangnga	Dibuk Phangnga Wittayayon	Taimuang Wittaya	Khor Yoa Wittaya
	19. Ranong	Satri Ranong	Kraburi Wittaya	La-oun Wittayakan
5.	20. Ratchaburi	Ratchaborikanukror	Rattanaratbumrung	Chongpran Wittaya
	21. Kanchaburi	Tamaka Wittayakom	Ladya Pittayakom	King Chulalongkorn Rommayaniket
	22. Prachuap Khiri Khan	Prachuap Wittayalai	Hau Hin	Samroiyod Wittayakom
	23. Petchaburi	Phormmanusorn	Chulapornratcha Wittayalai	Cha-um Khunying Nuengburi
	24. Samut Songkhram	Suttha Samut	Umpawan Wittayalai	Sakol Wisutti
	25. Suphun Buri	Kunnasud Suksalai	Samchuk Rattanapokaram	Sriprajun 'Matee Pramuk'
6.	26. Lop Buri	Piboon Wittayalai	Kokkratium Wittayalai	Ban Mi Wittaya
	27. Chai Nat	Chai Nat Pittayakom	Hunka Pittayakom	Wat Sing
	28. Ayutthaya	Ayutthaya Wittayalai	Jomsurang Uppathum	Pang Pra In
	29. Saraburi	Sara Buri Wittayakom	Muaklek Wittaya	Hin Kong Wittayakom
	30. Sing Buri	Sing Buri	Bangrajun Wittaya	Sing Pahu "Prasanmit Uppathum"
	31. Ang Thong	Ang Thong Pattamarat	Satri Angtong	Pamok Wittayaphum
	32. Uthai Thani	Uthai Wittayakom	Banrai Wittaya	Puttamongkol Wittaya
7.	33. Pitsanulok	Pitsanulok Pittayakom	Nakhornthai	Wat Boat Suksa
	34. Kamphaeng Phet	Kamphaengphet Pittayakom	Kanu Wittaya	Suk Ngam Wittaya
	35. Tak	Tak Pittayakom	Suppa Wittayakom	Wungprajob Wittayakom

	36. Nakhon Sawan	Nakornsawan	Nawamin Rachutit Mutchim	Koalei Wittaya
	37. Phichit	Phichit Pittayakom	Bangmulnakphum Wittayakom	PhosaiNgam Wittayakom
	38. Phetchabun	Phet Pittayakom	Boung Sampun Wittayakom	Subbon Wittayakom
	39. Sukhothai	Sukhothai Wittayakom	Tung Salieum Chanuphathum	Lithai Pittayakom
	40. Uttaradit	Uttaradit	Pichai	Tong San Khun Wittaya
8.	41. Chiang Mai	Wattanothai Phayab	Nawamin Rachutit Payab	Sarapi Pittayakom
	42. Chiang Rai	Samukki Wittayakom	Weingchai Wittayakom	Charaporn Ratcha Wittayalai
	43. Nan	Satri Sri Nan	Thawungpha Pittayakom	Borkloeer
	44. Phayao	Phayao Pittayakom	Dokkumtai Wittyakom	Phayao Prasanthawit
	45. Phare	Narirat	Wilaikeit Uppathum	Rong Kuang Anusorn
	46. Mae Hong Son	Hong Son Suksa	Pai Wittayakan	Mae Lanoi Daroonsik
	47. Lampang	Lampang Kullayani	Hangchat Wittaya	Mae tha Pracha Samukki
	48. Lamphun	Jukkom Kanathorn	Pasang	Pan Ban Pittayakom
9.	49. Udonthani	Udon Pittayanukul	Nong Han Wittaya	Nanokchum Wittayakom
	50. Khon Kaen	Kaen Nakorn Wittayalai	Munja Suksa	Pungpui Pattanasuksa
	52. Loei	Loei Pittayakom	Sri Songkram Wittaya	Pa In Plang Wittaya
	53. Sakon Nakhon	Sakonratcha Wittayanukul	Trium Udomsuksa North Eastern	Rom Kloa
	54. Nong Bau Lampoo	Nong Bau Pittayakan	Komsan Pittayason	Nawung Suksawit
	55. Nong Khai	Phathumtep Wittayakan	Nong Khai Wittayakan	Hin Ngoam Pittayakom

10.	56. Ubon Ratchathani	Nari Nukul	Det Udom	Warinchumrab
	57. Kalasin	Kalasin Pittayason	Yangtalad Wittayakan	Hui Poung Pittaya
	58. Nakhon Phanom	Piya Maharachelai	Renunakhon Wittayanukul	Nakhonphanom Wittayakom
	58. Maha Sarakham	Phadung Nari	Chieng Yern Pittayakom	Kudrung Prachason
	59. Mukdahan	Mukdahan	Komcha Ie Wittayakan	Poung Dad Wittayakan
	60. Yasothon	Yasothon Pittayakom	Kom Khoun Kaew Chanuphathum	Sai Mun Wittaya
	61. Roi Et	Roi Et Wittayalai	Suwaunaphum Pittayapaisan	Tong thani
	62. Ammat Charoen	Ammat Chareon	Pathum Rachwongsa	Nayom Wittayakan
11.	63. Nakhon Ratchasima	Ratchasima Wittayalai	Pak Chong	Sida Wittaya
	64. Chaiyaphum	Chaiyaphum Pukdichumpol	Phukeaw	Pukdi Chumpol Wittaya
	65. Buriram	Buriram Pittayakom	Satouk	Churaporn Ratcha Wittayalai
	66. Si Sa Ket	Satri Siriket	Kuntaluk Wittaya	Sri Rattana Wittaya
	67. Surin	Sura Wittayakan	Thatum Pracha Sermwit	Chumpol Wittayason
12.	68. Chonburi	Chonrat Umrung	Sriracha	Sattahip Wittayakom
	69. Chanthaburi	Benjamarachutit	Thamai "Phunsawat Ratchanukul"	Nayai-arm Pittayakom
	70. Chachoengsao	Dud Daruni	Trium Udom Suksa Pattanakan	Bangpakong "Boworn Wittayayon"
	71. Trad	Trad Trakankhun	Koa Saming Wittayakom	Trad Sunsern Wittayakom
	72. Nakhon Nayok	Nakhonnayok Wittayakom	Banna "Nayok Pittayakan"	Muang Nakhon Nayok
	73. Prachin Buri	Prachin Kullayani	Kabin Wittaya	Sri Mahosod

	74. Rayong	Rayong Wittayakom	Klang "Wittayasataworn"	Mabtaputpun Pittayakan
	75. Sa Kaeo	Sa Kaeo	Arunyapratet	Thakaserm Pittaya
13.	76. Bangkok	Trium Udom Suksa (Group 2) Sai Num Poung (Group 4) Suksa Nari (Group 7) Suankulab Wittayalai (Group1 1 referred Group 3)	Tep Li La (Group 5) Punya Worakhun (Group 8)	Silajapipat (Group 1) Wat Noi Nai (Group 6)
Private School		Saint Gabriel's College Bangkok Print Royal Cheingmai Dara Wittayalai Chiengmai Rachinibon Bangkok (Queen College)		
Demonstrational University School		Khon Kaen Universiry Cheing Mai University Songkla Nakkarin University Kasetsat University		
Religious Affairs School		Wat Si Sa Ket Nong Khai Wat Phra Tat Doi Saket Cheingmai Wat Sutat Tepwararam Bangkok Wat Sommanutwararam Udonthani		

APPENDIX D

Actual Form	SUPPLEMENT A

Questionnaire on Teacher Interaction (QTI)

Actual Form

This questionnaire asks you to describe the behaviour of your teacher. This is NOT a test. Your opinion is what is wanted.

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

	Never				Always
This teacher expresses himself/herself clearly.	0	1	2	3	4

If you think that your teacher always expresses himself/herself clearly, circle the 4. If you think your teacher never expresses himself/herself clearly, circle the 0. You also can choose the numbers 1, 2 and 3 which are in between. If you want to change your answer, cross it out and circle a new number. Thank for your cooperation.

Don' t forget to write the name of the teacher and other details at the top of the reverse side of this page.

Name____________________School____________________Class__________

	Never			Always
1. This teacher talks enthusiastically about her/his subject.	0 1	2	3	4
2. This teacher trusts us.	0 1	2	3	4
3. This teacher seems uncertain.	0 1	2	3	4
4. This teacher gets angry unexpectedly.	0 1	2	3	4
5. This teacher explains things clearly.	0 1	2	3	4
6. If we don't agree with this teacher, we can talk about it.	0 1	2	3	4
7. This teacher is hesitant.	0 1	2	3	4
8. This teacher gets angry quickly.	0 1	2	3	4
9. This teacher holds our attention.	0 1	2	3	4
10. This teacher is willing to explain things again.	0 1	2	3	4
11. This teacher acts as if she/he does not know what to do.	0 1	2	3	4
12. This teacher is too quick to correct us when we break a rule.	0 1	2	3	4
13. This teacher knows everything that goes on in the classroom.	0 1	2	3	4
14. If we have something to say, this teacher will listen.	0 1	2	3	4
15. This teacher lets us boss her/him around.	0 1	2	3	4
16. This teacher is impatient.	0 1	2	3	4
17. This teacher is a good leader.	0 1	2	3	4
18. This teacher realizes when we don't understand.	0 1	2	3	4
19. This teacher is not sure what to do when we fool around.	0 1	2	3	4
20. It is easy to pick a fight with this teacher.	0 1	2	3	4
21. This teacher helps us with our work.	0 1	2	3	4
22. This teacher is patient.	0 1	2	3	4
23. It's easy to make a fool out of this teacher.	0 1	2	3	4
24. This teacher is sarcastic.	0 1	2	3	4

25. This teacher helps us with our work.	0 1	2	3	4
26. We can decide some things in this teacher's class.	0 1	2	3	4
27. This teacher thinks that we cheat.	0 1	2	3	4
28. This teacher is strict.	0 1	2	3	4
29. This teacher is friendly.	0 1	2	3	4
30. We can influence this teacher.	0 1	2	3	4
31. This teacher thinks that we don't know anything.	0 1	2	3	4
32. We have to be silent in this teacher's class.	0 1	2	3	4
33. This teacher is someone we can depend on.	0 1	2	3	4
34. This teacher lets us fool around in class.	0 1	2	3	4
35. This teacher puts us down.	0 1	2	3	4
36. This teacher's tests are hard.	0 1	2	3	4
37. This teacher has a sense of humour.	0 1	2	3	4
38. This teacher lets us get away with a lot in class.	0 1	2	3	4
39. This teacher thinks that we can't do things well.	0 1	2	3	4
40. This teacher's standards are very high.	0 1	2	3	4
41. This teacher can take a joke.	0 1	2	3	4
42. This teacher gives us a lot of free time in class.	0 1	2	3	4
43. This teacher seems dissatisfied.	0 1	2	3	4
44. This teacher is severe when marking paper.	0 1	2	3	4
45. This teacher's class is pleasant.	0 1	2	3	4
46. This teacher is lenient.	0 1	2	3	4
47. This teacher is suspicious.	0 1	2	3	4
48. We are afraid of this teacher.	0 1	2	3	4

Preferred Form

SUPPLEMENT B

Questionnaire on Teacher Interaction (QTI)

Preferred Form

This questionnaire asks you to describe the behaviour of your teacher. This is NOT a test. Your opinion is what is wanted.

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

	Never				Always
This teacher expresses himself/herself clearly.	0	1	2	3	4

If you think that your teacher always expresses himself/herself clearly, circle the 4. If you think your teacher never expresses himself/herself clearly, circle the 0. You also can choose the numbers 1, 2 and 3 which are in between. If you want to change your answer, cross it out and circle a new number. Thank for your cooperation.

Don' t forget to write the name of the teacher and other details at the top of the reverse side of this page.

Name____________________School____________________Class__________

	Never Always
1. This teacher would talk enthusiastically about her/his subject.	0 1 2 3 4
2. This teacher would trust us.	0 1 2 3 4
3. This teacher would seem uncertain.	0 1 2 3 4
4. This teacher would get angry unexpectedly.	0 1 2 3 4
5. This teacher would explain things clearly.	0 1 2 3 4
6. If we don't agree with this teacher, we would talk about it.	0 1 2 3 4
7. This teacher would be hesitant.	0 1 2 3 4
8. This teacher would get angry quickly.	0 1 2 3 4
9. This teacher would hold our attention.	0 1 2 3 4
10. This teacher would be willing to explain things again.	0 1 2 3 4
11. This teacher would act as if she/he does not know what to do.	0 1 2 3 4
12. This teacher would be too quick to correct us when we break a rule.	0 1 2 3 4
13. This teacher would know everything that goes on in the classroom.	0 1 2 3 4
14. If we have something to say, this teacher would be listening.	0 1 2 3 4
15. This teacher would let us boss her/him around.	0 1 2 3 4
16. This teacher would be impatient.	0 1 2 3 4
17. This teacher would be a good leader.	0 1 2 3 4
18. This teacher would realize when we don't understand.	0 1 2 3 4
19. This teacher would be not sure what to do when we fool around.	0 1 2 3 4
20. It would be easy to pick a fight with this teacher.	0 1 2 3 4
21. This teacher would help us with our work.	0 1 2 3 4
22. This teacher would be patient.	0 1 2 3 4
23. It would be easy to make a fool out of this teacher.	0 1 2 3 4
24. This teacher would be sarcastic.	0 1 2 3 4

25. This teacher would help us with our work.	0 1 2 3 4
26. We would decide some things in this teacher's class.	0 1 2 3 4
27. This teacher would think that we cheat.	0 1 2 3 4
28. This teacher would be strict.	0 1 2 3 4
29. This teacher would be friendly.	0 1 2 3 4
30. We would influence this teacher.	0 1 2 3 4
31. This teacher would think that we don't know anything.	0 1 2 3 4
32. We would have to be silent in this teacher's class.	0 1 2 3 4
33. This teacher would be someone we can depend on.	0 1 2 3 4
34. This teacher would let us fool around in class.	0 1 2 3 4
35. This teacher would put us down.	0 1 2 3 4
36. This teacher's tests would be hard.	0 1 2 3 4
37. This teacher would have a sense of humour.	0 1 2 3 4
38. This teacher would let us get away with a lot in class.	0 1 2 3 4
39. This teacher would think that we wouldn't do things well.	0 1 2 3 4
40. This teacher's standards would be very high.	0 1 2 3 4
41. This teacher would take a joke.	0 1 2 3 4
42. This teacher would give us a lot of free time in class.	0 1 2 3 4
43. This teacher would seem dissatisfied.	0 1 2 3 4
44. This teacher would be severe when marking paper.	0 1 2 3 4
45. This teacher's class would be pleasant.	0 1 2 3 4
46. This teacher would be lenient.	0 1 2 3 4
47. This teacher would be suspicious.	0 1 2 3 4
48. We would be afraid of this teacher.	0 1 2 3 4

| พฤติกรรมที่เป็นจริงขอ |

| SUPPLEMENT A |

Questionnaire on Teacher Interaction (QTI)

(Thai Version)

แบบสำรวจความคิดเห็นของนักเรียนที่มีต่อพฤติกรรมของอาจารย์สอนวิชาฟิสิกส์ในโรงเรียนมัธยมศึกษา

ชื่อ.......................................เลขที่......ชั้นมัธยมศึกษาปีที่ 6/....................

โรงเรียน.................................ตำบล.............................อำเภอ... ....

จังหวัด....................เขตการศึกษาที่.........เขตพื้นที่บริหารการศึกษาที่..................

ประเภทโรงเรียน (...) โรงเรียนรัฐบาล (...) โรงเรียนเอกชน (...) โรงเรียนสาธิต (...) โรงเรียนสาธิตบาลี

คำชี้แจง

1. แบบสอบถามนี้เกี่ยวข้องกับพฤติกรรมของอาจารย์ผู้สอนที่มีต่อการจัดกิจกรรมการเรียนการสอนในชั้นเรียนวิชาฟิสิกส์ของโรงเรียนมัธยมศึกษาตอนปลาย ในประเทศไทย
2. ให้นักเรียนวงกลมล้อมรอบตัวเลขที่ตรงกับความคิดเห็นของนักเรียนมากที่สุดที่เกี่ยวกับพฤติกรรมของอาจารย์ผู้สอนที่มีต่อการจัดกิจกรรมการเรียนการสอนในชั้นเรียนวิชาฟิสิกส์ของโรงเรียนมัธยมศึกษาตอนปลาย ในประเทศไทย

    0. หมายถึง อาจารย์ไม่เคยแสดงพฤติกรรมให้พบเห็นเลย
    1. หมายถึง อาจารย์แสดงพฤติกรรมให้พบเห็นนาน ๆ ครั้ง หรือไม่บ่อย
    2. หมายถึง อาจารย์แสดงพฤติกรรมให้พบเห็นเป็นบางครั้ง
    3. หมายถึง อาจารย์แสดงพฤติกรรมให้พบเห็นบ่อย ๆ ครั้ง

4. หมายถึง
อาจารย์แสดงพฤติกรรมให้พบเห็นเป็นประจำอย่างสม่ำเสมอ

3. โปรดแน่ใจว่านักเรียนตอบครบทุกคำถาม ถ้าต้องการเปลี่ยนคำตอบให้ทำเครื่องหมายกากบาททับหมายเลขนั้น แล้ววงกลมล้อมรอบข้ออื่นที่นักเรียมีความคิดเห็นที่เป็นสภาพที่เป็นจริงกว่า
4. บางข้อความในแบบสอบถามนี้อาจมีลักษณะของคำถามที่คล้ายกัน นักเรียนไม่ต้องกังวลเกี่ยวกับคำถามนี้ โดยนักเรียนสามารถจะตอบแบบสอบถามไปตามสภาพที่นักเรียนมีความคิดเห็นนั้น
5. ไม่มีคำตอบที่ถูกหรือผิด ความคิดเห็นของนักเรียนจากแบบสอบถามนี้จะเป็นส่วนหนึ่งในการนำไปพิจารณาปรับปรุงในการจัดการเรียนการสอนของอาจารย์ต่อไป

ขอขอบคุณนักเรียนเป็นอย่างยิ่งในการให้ความร่วมมือในการตอบแบบสอบถามอย่างสมบูรณ์ที่สุด

(ต้นสกุล ศานติบูรณ์)
นักศึกษาปริญญาเอก มหาวิทยาลัยเทคโนโลยีเคอร์ติน ประเทศออสเตรเลีย

ข้อที่	*พฤติกรรมของอาจารย์ผู้สอนที่มีต่อการจัดกิจกรรมการเรียนการสอนในชั้นเรียนวิชาฟิสิกส์ในความคิดเห็นของนักเรียนชั้นมัธยมศึกษาปีที่ 6 ของประเทศไทย*	0	1	2	3	4	เฉพาะผู้วิจัย
1.	อาจารย์มีความกระตือรือร้นในการสอน	0	1	2	3	4	
2.	อาจารย์มีความเชื่อใจในการทำกิจกรรมต่าง ๆ ของนักเรียน	0	1	2	3	4	
3.	อาจารย์แสดงความไม่มั่นใจในการสอน	0	1	2	3	4	
4.	อาจารย์แสดงอารมณ์โกรธอย่างคาดไม่ถึง	0	1	2	3	4	
5.	อาจารย์อธิบายเนื้อหาต่าง ๆ ได้อย่างกระจ่าง	0	1	2	3	4	
6.	อาจารย์อนุญาตให้นักเรียนแสดงความคิดเห็นได้เมื่อมีความคิดเห็นไม่ตรงกับอาจารย์	0	1	2	3	4	
7.	อาจารย์แสดงความลังเลในการสอน	0	1	2	3	4	
8.	อาจารย์แสดงอารมณ์ฉุนเฉียวง่ายเมื่อมีปัญหาเกิดขึ้น	0	1	2	3	4	

9	อาจารย์รับรู้ถึงความมุ่งมั่นในการเรียนของนักเรียน	0	1	2	3	4	
10	อาจารย์มีความยินดีเสมอที่จะอธิบายเนื้อหาใหม่เมื่อนักเรียนไม่เข้าใจ	0	1	2	3	4	
11	อาจารย์แสดงท่าทีลังเลที่จะอธิบายในสิ่งที่นักเรียนไม่เข้าใจ	0	1	2	3	4	
12	อาจารย์ไม่สามารถแก้ไขสถานการณ์ได้เมื่อนักเรียนคัดค้านเนื้อหาที่อาจารย์สอน	0	1	2	3	4	
13	อาจารย์ทราบทุกอย่างในเนื้อหาที่ดำเนินการสอน	0	1	2	3	4	
14	ถ้านักเรียนจะแสดงความคิดเห็นใด ๆ อาจารย์จะรับฟังความคิดเห็นของนักเรียนเสมอ	0	1	2	3	4	
15	อาจารย์ชอบพูดนอกเรื่องในระหว่างทำการสอน	0	1	2	3	4	
16	อาจารย์ขาดความอดทนที่จะแก้ปัญหาต่าง ๆ ที่อาจจะเกิดขึ้นระหว่างการเรียนการสอน	0	1	2	3	4	
17	อาจารย์เป็นผู้นำที่ดีในด้านวิชาการ	0	1	2	3	4	
18	อาจารย์รับรู้ว่ามีนักเรียนยังไม่เข้าใจในเนื้อหาที่อาจารย์กำลังสอน	0	1	2	3	4	
19	อาจารย์มีความลังเลว่าจะดำเนินการสอนอย่างไรเมื่อนักเรียนไม่เข้าใจ	0	1	2	3	4	
20	ถ้านักเรียนมีความคิดเห็นไม่ตรงกับอาจารย์ นักเรียนไม่สามารถที่จะแสดงความคิดเห็นโต้แจ้งอาจารย์ได้เลย	0	1	2	3	4	
21	บุคลิกของอาจารย์มีความเหมาะสมกับความเป็นครูฟิสิกส์	0	1	2	3	4	
22	อาจารย์มีความอดทนสูงต่อการจัดกิจกรรมการเรียนรู้ในชั้นเรียน	0	1	2	3	4	
23	ถ้านักเรียนต้องการให้อาจารย์แก้ปัญหาใด ๆ อาจารย์จะแสดงความลังเลที่จะแก้ปัญหา	0	1	2	3	4	
24	อาจารย์ชอบพูดจาเสียดสีเปรียบเปรยนักเรียน	0	1	2	3	4	
25	อาจารย์ให้ความช่วยเหลือนักเรียน	0	1	2	3	4	
26	อาจารย์อนุญาตให้นักเรียนตัดสินใจด้วยตนเองที่จะดำเนินกิจกรรมตามความสนใจ	0	1	2	3	4	
27	อาจารย์ชอบคิดว่านักเรียนชอบแสดงการลองภูมิอาจารย์	0	1	2	3	4	
28	อาจารย์แสดงความเข้มงวดในชั้นเรียนฟิสิกส์	0	1	2	3	4	

29	อาจารย์แสดงความเป็นมิตรต่อนักเรียนอย่างสม่ำเสมอ	0	1	2	3	4	
30	อาจารย์คิดว่านักเรียนมีอิทธิพลต่อการจัดกิจกรรมการเรียนการสอนของอาจารย์	0	1	2	3	4	
31	อาจารย์คิดอยู่เสมอว่านักเรียนเรียนไม่เก่งเลยในวิชาฟิสิกส์	0	1	2	3	4	
32	นักเรียนต้องเงียบในขณะที่อาจารย์ดำเนินการสอน	0	1	2	3	4	
33	อาจารย์เป็นที่พึ่งของนักเรียนได้	0	1	2	3	4	
34	อาจารย์เปิดโอกาสให้นักเรียนตัดสินใจที่จะดำเนินกิจกรรมร่วมกันในชั้นเรียนได้	0	1	2	3	4	
35	อาจารย์แสดงพฤติกรรมที่ทำให้นักเรียนมีความรู้สึกด้อยค่าลง	0	1	2	3	4	
36	ข้อสอบของอาจารย์ในรายวิชาฟิสิกส์นั้นเป็นข้อสอบที่ยาก	0	1	2	3	4	
37	อาจารย์มีอารมณ์สนุกสนานในระหว่างการทำการสอน	0	1	2	3	4	
38	อาจารย์จะไม่ทิ้งปัญหาใด ๆ ไว้เมื่อสิ้นสุดการเรียนการสอน	0	1	2	3	4	
39	อาจารย์ชอบคิดว่านักเรียนไม่สามารถที่จะแก้ปัญหาใด ๆ ได้ตามลำพังด้วยตัวนักเรียนเอง	0	1	2	3	4	
40	อาจารย์ตั้งเกณฑ์ในการให้ระดับผลการเรียนไว้ค่อนข้างสูง	0	1	2	3	4	
41	อาจารย์จะแทรกเรื่องตลกขบขันในระหว่างทำการสอนเพื่อให้บรรยากาศที่ดีในชั้นเรียน	0	1	2	3	4	
42	อาจารย์ให้เวลาอย่างพอเพียงต่อนักเรียนที่จะดำเนินการทดลองหรือกิจกรรมต่าง ๆ	0	1	2	3	4	
43	อาจารย์มีทีท่าแสดงความไม่พอใจนักเรียนขณะทำการสอนอย่างสม่ำเสมอ	0	1	2	3	4	
44	อาจารย์เข้างวดการให้คะแนนแก่นักเรียนในการประเมินผลแต่ละครั้ง	0	1	2	3	4	
45	บรรยากาศในชั้นเรียนมีความสนุกสนาน	0	1	2	3	4	
46	อาจารย์มีความเตตาธรรมสูงต่อนักเรียน	0	1	2	3	4	
47	อาจารย์แสดงพฤติกรรมที่ไม่วางใจต่อนักเรียนที่จะดำเนินกิจกรรมด้วยตัวนักเรียนเอง	0	1	2	3	4	
48	นักเรียนมีความรู้สึกกลัวต่ออาจารย์ผู้สอนในวิชาฟิสิกส์	0	1	2	3	4	

พฤติกรรมของผู้สอนที่พึง

SUPPLEMENT A

Questionnaire on Teacher Interaction (QTI)

(Thai Version)

แบบสำรวจความคิดเห็นของนักเรียนที่มีต่อพฤติกรรมที่พึงประสงค์ของอาจารย์สอนวิชาฟิสิกส์

ชื่อ.......................................เลขที่......ชั้นมัธยมศึกษาปีที่ 6/...................

โรงเรียน.................................ตำบล.............................อำเภอ... ....

จังหวัด.....................เขตการศึกษาที่.........เขตพื้นที่บริหารการศึกษาที่.................

ประเภทโรงเรียน (...) โรงเรียนรัฐบาล (...) โรงเรียนเอกชน (...) โรงเรียนสาธิต (...) โรงเรียนสาธิตบาลี

คำชี้แจง

1. แบบสอบถามนี้เกี่ยวข้องกับพฤติกรรมของอาจารย์ผู้สอนที่มีต่อการจัดกิจกรรมการเรียนการสอนในชั้นเรียนวิชาฟิสิกส์ของโรงเรียนมัธยมศึกษาตอนปลาย ในประเทศไทยตามที่นักเรียนประสงค์จะให้มี
2. ให้นักเรียนวงกลมล้อมรอบตัวเลขที่ตรงกับความคิดเห็นของนักเรียนมากที่สุดที่เกี่ยวกับพฤติกรรมของอาจารย์ผู้สอนที่มีต่อการจัดกิจกรรมการเรียนการสอนในชั้นเรียนวิชาฟิสิกส์ของโรงเรียนมัธยมศึกษาตอนปลาย ในประเทศไทย ที่ควรจะมีขึ้นตามความประสงค์ของนักเรียน
   0. หมายถึง อาจารย์ไม่เคยแสดงพฤติกรรมให้พบเห็นเลย
   1. หมายถึง อาจารย์แสดงพฤติกรรมให้พบเห็นนาน ๆ ครั้ง หรือไม่บ่อย
   2. หมายถึง อาจารย์แสดงพฤติกรรมให้พบเห็นเป็นบางครั้ง
   3. หมายถึง อาจารย์แสดงพฤติกรรมให้พบเห็นบ่อย ๆ ครั้ง
   4. หมายถึง อาจารย์แสดงพฤติกรรมให้พบเห็นเป็นประจำอย่างสม่ำเสมอ

3. โปรดแน่ใจว่านักเรียนตอบครบทุกคำถาม ถ้าต้องการเปลี่ยนคำตอบให้ทำเครื่องหมายกากบาททับหมายเลขนั้น แล้ววงกลมล้อมรอบข้ออื่นที่นักเรียมีความคิดเห็นที่เป็นสภาพที่เป็นจริงกว่า
4. บางข้อความในแบบสอบถามนี้อาจมีลักษณะของคำถามที่คล้ายกัน นักเรียนไม่ต้องกังวลเกี่ยวกับคำถามนี้ โดยนักเรียนสามารถจะตอบแบบสอบถามไปตามสภาพที่นักเรียนมีความคิดเห็นนั้น
5. ไม่มีคำตอบที่ถูกหรือผิด ความคิดเห็นของนักเรียนจากแบบสอบถามนี้จะเป็นส่วนหนึ่งในการนำไปพิจารณาปรับปรุงในการจัดการเรียนการสอนของอาจารย์ต่อไป

ขอขอบคุณนักเรียนเป็นอย่างยิ่งในการให้ความร่วมมือในการตอบแบบสอบถามอย่างสมบูรณ์ที่สุด

(ต้นสกุล ศานติบูรณ์)
นักศึกษาปริญญาเอก มหาวิทยาลัยเทคโนโลยีเคอร์ติน ประเทศออสเตรเลีย

ข้อที่	*พฤติกรรมของอาจารย์ผู้สอนที่มีต่อการจัดกิจกรรมการเรียนการสอนในชั้นเรียนวิชาฟิสิกส์ในความคิดเห็นที่นักเรียนพึงประสงค์ที่จะให้มีขึ้นของนักเรียนชั้นมัธยมศึกษาปีที่ 6 ของประเทศไทย*	0	1	2	3	4	เฉพาะผู้วิจัย
1.	อาจารย์ควรจะมีความกระตือรือร้นในการสอน	0	1	2	3	4	
2.	อาจารย์ควรจะมีความเชื่อใจในการทำกิจกรรมต่าง ๆ ของนักเรียน	0	1	2	3	4	
3.	อาจารย์ควรจะแสดงความไม่มั่นใจในการสอน	0	1	2	3	4	
4.	อาจารย์ควรจะแสดงอารมณ์โกรธอย่างคาดไม่ถึง	0	1	2	3	4	
5.	อาจารย์ควรจะอธิบายเนื้อหาต่าง ๆ ได้อย่างกระจ่าง	0	1	2	3	4	
6.	อาจารย์ควรจะอนุญาตให้นักเรียนแสดงความคิดเห็นได้เมื่อมีความคิดเห็นไม่ตรงกับอาจารย์	0	1	2	3	4	
7.	อาจารย์ควรจะแสดงความลังเลในการสอน	0	1	2	3	4	
8.	อาจารย์ควรจะแสดงอารมณ์ฉุนเฉียวง่ายเมื่อมีปัญหาเกิดขึ้น	0	1	2	3	4	
9	อาจารย์ควรจะรับรู้ถึงความตั้งใจเรียนของนักเรียน	0	1	2	3	4	
10		0	1	2	3	4	
11	อาจารย์ควรจะมีความยินดีที่จะอธิบายเนื้อหาใหม่เ	0	1	2	3	4	

12	มื่อนักเรียนไม่เข้าใจ อาจารย์ควรจะแสดงท่าทีลังเลที่จะอธิบายในสิ่งที่นั กเรียนไม่เข้าใจ อาจารย์ควรจะไม่สามารถแก้ไขสถานการณ์ได้เมื่ อนักเรียนคัดค้านเนื้อหาที่อาจารย์สอน	0	1	2	3	4	
13 14 15 16	อาจารย์ควรจะทราบทุกอย่างในเนื้อหาที่ดำเนินกา รสอน ถ้านักเรียนควรจะแสดงความคิดเห็นใด ๆ อาจารย์จะรับฟังความคิดเห็นของนักเรียนเสมอ อาจารย์ควรจะชอบพูดนอกเรื่องในระหว่างทำการ สอน อาจารย์ควรจะขาดความอดทนที่จะแก้ปัญหาต่าง ๆ ที่อาจจะเกิดขึ้นระหว่างการเรียนการสอน	0 0 0 0	1 1 1 1	2 2 2 2	3 3 3 3	4 4 4 4	
17 18 19 20	อาจารย์ควรจะเป็นผู้นำที่ดีในด้านวิชาการ อาจารย์ควรจะรับรู้ว่ามีนักเรียนยังไม่เข้าใจในเนื้อ หาที่อาจารย์กำลังสอน อาจารย์ควรจะมีความลังเลจะดำเนินการสอนอย่าง ไรถ้านักเรียนไม่เข้าใจ ถ้านักเรียนควรจะมีความคิดเห็นไม่ตรงกับอาจารย์ นักเรียนไม่สามารถที่จะแสดงความคิดเห็นโต้แจ้งอ าจารย์ได้เลย	0 0 0 0	1 1 1 1	2 2 2 2	3 3 3 3	4 4 4 4	
21 22 23 24	บุคลิกของอาจารย์ควรจะมีความเหมาะสมกับความ เป็นครูฟิสิกส์ อาจารย์ควรจะมีความอดทนสูงต่อการจัดกิจกรรม การเรียนรู้ในชั้นเรียน ถ้านักเรียนต้องการให้อาจารย์แก้ปัญหาใด ๆ อาจารย์ควรจะแสดงความลังเลที่จะแก้ปัญหา อาจารย์ควรจะพูดจาเสียดสีเปรียบเปรยนักเรียน	0 0 0 0	1 1 1 1	2 2 2 2	3 3 3 3	4 4 4 4	
25 26 27 28	อาจารย์ควรจะให้ความช่วยเหลือนักเรียน อาจารย์ควรจะอนุญาตให้นักเรียนตัดสินใจด้วยต นเองที่จะดำเนินกิจกรรมตามความสนใจ อาจารย์ควรจะคิดว่านักเรียนชอบแสดงการลองภู มิอาจารย์ อาจารย์ควรจะแสดงความเข้มงวดในชั้นเรียนฟิสิก ส์	0 0 0 0	1 1 1 1	2 2 2 2	3 3 3 3	4 4 4 4	
29 30	อาจารย์ควรจะแสดงความเป็นมิตรต่อนักเรียนอย่า งสม่ำเสมอ	0	1	2	3	4	

31	อาจารย์ควรจะคิดว่านักเรียนมีอิทธิพลต่อการจัดกิจกรรมการเรียนการสอนของอาจารย์	0	1	2	3	4	
32	อาจารย์ควรจะคิดอยู่เสมอว่านักเรียนเรียนไม่เก่งเลยในวิชาฟิสิกส์	0	1	2	3	4	
	นักเรียนควรจะเงียบในขณะที่อาจารย์ดำเนินการสอน	0	1	2	3	4	
33	อาจารย์ควรจะเป็นที่พึ่งของนักเรียนได้	0	1	2	3	4	
34	อาจารย์ควรจะเปิดโอกาสให้นักเรียนตัดสินใจที่จะดำเนินกิจกรรมร่วมกันในชั้นเรียนได้	0	1	2	3	4	
35	อาจารย์ควรจะแสดงพฤติกรรมที่ทำให้นักเรียนมีความรู้สึกด้อยค่าลง	0	1	2	3	4	
36	ข้อสอบของอาจารย์ในรายวิชาฟิสิกส์นั้นควรจะเป็นข้อสอบที่ยาก	0	1	2	3	4	
37	อาจารย์ควรจะมีอารมณ์สนุกสนานในระหว่างการทำการสอน	0	1	2	3	4	
38	อาจารย์ควรจะไม่ทิ้งปัญหาใด ๆ ไว้เมื่อสิ้นสุดการเรียนการสอน	0	1	2	3	4	
39	อาจารย์ควรจะคิดว่านักเรียนไม่สามารถที่จะแก้ปัญหาใด ๆ ได้ตามลำพังของนักเรียน	0	1	2	3	4	
40	อาจารย์ควรจะตั้งเกณฑ์ในการให้ระดับผลการเรียนไว้ค่อนข้างสูง	0	1	2	3	4	
41	อาจารย์ควรจะแทรกเรื่องตลกขบขันในระหว่างทำการสอนเพื่อให้บรรยากาศที่ดีในชั้นเรียน	0	1	2	3	4	
42	อาจารย์ควรจะให้เวลาอย่างพอเพียงต่อนักเรียนที่จะดำเนินการทดลองหรือกิจกรรมต่าง ๆ	0	1	2	3	4	
43	อาจารย์ควรจะมีทีท่าแสดงความไม่พอใจนักเรียนขณะทำการสอนอย่างสม่ำเสมอ	0	1	2	3	4	
44	อาจารย์ควรจะเข้มงวดการให้คะแนนแก่นักเรียนในการประเมินผลแต่ละครั้ง	0	1	2	3	4	
45	บรรยากาศในชั้นเรียนควรจะมีความสนุกสนาน	0	1	2	3	4	
46	อาจารย์ควรจะมีความเตตาธรรมสูงต่อนักเรียน	0	1	2	3	4	
47	อาจารย์ควรจะแสดงพฤติกรรมที่ไม่วางใจต่อนักเรียนที่จะดำเนินกิจกรรมด้วยตัวนักเรียนเอง	0	1	2	3	4	
48	นักเรียนควรจะมีความรู้สึกกลัวต่ออาจารย์ผู้สอนในวิชาฟิสิกส์	0	1	2	3	4	

APPENDIX E

Actual Form

SUPPLEMENT A

Physics Laboratory Environment Inventory (PLEI)

Actual Form

Directions

This questionnaire contains statements about 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 you practice actually takes place	ALMOST NEVER
2	if you practice actually takes place	SELDOM
3	if you practice actually takes place	SOMETIME
4	if you practice actually takes place	OFTEN
5	if you practice actually takes place	VERY OFTEN

Be sure to give an answer for all questions. If you change your mind about an answer, just cross it out and circle another.

Some statements in this question are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Practice Example. Suppose that you were given the statement: "I choose my partners for laboratory experiments" You would need to decide whether you thought that you actually choose your partners Almost Never, Seldom, Sometime, Often or Very Often. For example, if you selected Very Often, you would circle the number 5.

Don't forget to write your name and other details at the top of the reverse side of the page.

Name__________________School__________________Class______________

Remember that you are describing your actual classroom	1 2 3 4 5	For Teacher's use
1. I get on well with students in this laboratory class.	1 2 3 4 5	____
2. There is opportunity for me to pursue my physics interests in this laboratory class.	1 2 3 4 5	____
3.What I do in our regular physics class is unrelated to my laboratory work	1 2 3 4 5	R ____
4. My laboratory class has clear rules to guide my activities.	1 2 3 4 5	____
5. I find that the laboratory is crowded when I am doing experiments.	1 2 3 4 5	R ____
6. I have little change to get to know other students in this laboratory class	1 2 3 4 5	R ____
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 physics class.	1 2 3 4 5	R ____
9. My laboratory class is rather informal and few rules are imposed on me.	1 2 3 4 5	R ____
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 help me.	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 physics 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	R ____
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 physics class sessions during laboratory activities.	1 2 3 4 5	____
19. There is a 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 this poor working order.	1 2 3 4 5	R ____
21. I am able to depend on other students for help during laboratory class.	1 2 3 4 5	____
22. In my laboratory sessions, I do different experiments than some of the 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	R ____
24. There are few fixed rule for me to follow in laboratory sessions.	1 2 3 4 5	R ____
25. I find that the laboratory is hot and stuffy.	1 2 3 4 5	R ____
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	R ____
27. In my laboratory sessions, the teacher decides the best way for me to carry out the laboratory experiments.	1 2 3 4 5	R ____
28. What I do in laboratory sessions helps me to understand the theory covered in regular physics classes.	1 2 3 4 5	____
29. The teacher outlines 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 physics class work are unrelated.	1 2 3 4 5	R ____
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	____

Preferred Form

SUPPLEMENT B

Physics Laboratory Environment Inventory (PLEI)

Actual Form

Directions

This questionnaire contains statements about practices which could take place in this laboratory class. You will be asked **how often** each practice **prefer** each practice to take 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 you would prefer the practice takes place	ALMOST NEVER
2	if you would prefer the practice takes place	SELDOM
3	if you would prefer the practice takes place	SOMETIME
4	if you would prefer the practice takes place	OFTEN
5	if you would prefer the practice takes place	VERY OFTEN

Be sure to give an answer for all questions. If you change your mind about an answer, just cross it out and circle another.

Some statements in this question are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Practice Example. Suppose that you were given the statement: "I choose my partners for laboratory experiments" You would need to decide whether you thought that you actually choose your partners Almost Never, Seldom, Sometime, Often or Very Often. For example, if you selected Very Often, you would circle the number 5.

Don't forget to write your name and other details at the top of the reverse side of the page.

Name____________________School____________________Class______________

Remember that you are describing your actual classroom	1 2 3 4 5	For Teacher's use
1. I would get on well with students in this laboratory class.	1 2 3 4 5	____
2. There would be opportunity for me to pursue my physics interests in this laboratory class.	1 2 3 4 5	____
3. What I do in our regular physics class would be unrelated to my laboratory work	1 2 3 4 5	R ____
4. My laboratory class would have clear rules to guide my activities.	1 2 3 4 5	____
5. I would find that the laboratory is crowded when I am doing experiments.	1 2 3 4 5	R ____
6. I would have little change to get to know other students in this laboratory class	1 2 3 4 5	R ____
7. In this laboratory class, I would be required to design my own experiments to solve a given problem.	1 2 3 4 5	____
8. The laboratory work would be unrelated to the topics that I am studying in my physics class.	1 2 3 4 5	R ____
9. My laboratory class would be rather informal and few rules are imposed on me.	1 2 3 4 5	R ____
10. The equipment and materials that I need for laboratory activities would be readily available	1 2 3 4 5	____
11. Members of this laboratory class would help me.	1 2 3 4 5	____
12. In my laboratory sessions, other students collect different data than I would for the same problem.	1 2 3 4 5	____
13. My regular physics class work would be integrated with laboratory activities.	1 2 3 4 5	____
14. I would be required to follow certain rules in the laboratory.	1 2 3 4 5	____
15. I would be ashamed of the appearance of this laboratory.	1 2 3 4 5	R ____
16. I would get to know students in this laboratory class well.	1 2 3 4 5	____
17. I would be allowed to go beyond the regular laboratory exercise and do some experimenting of my own.	1 2 3 4 5	____
18. I would use the theory from my regular physics class sessions during laboratory activities.	1 2 3 4 5	____
19. There would be a recognized way for me to do things safely in this laboratory	1 2 3 4 5	____
20. The laboratory equipment which I use would be in this poor working order.	1 2 3 4 5	R ____
21. I would be able to depend on other students for help during laboratory class.	1 2 3 4 5	____
22. In my laboratory sessions, I would do different experiments than some of the other students	1 2 3 4 5	____
23. The topics covered in regular science class work would be quite different from topics with which I deal in laboratory sessions.	1 2 3 4 5	R ____
24. There would be few fixed rule for me to follow in laboratory sessions.	1 2 3 4 5	R ____
25. I would find that the laboratory is hot and stuffy.	1 2 3 4 5	R ____
26. It would take me a long time to get to know everybody by his/her first name in this laboratory class.	1 2 3 4 5	R ____
27. In my laboratory sessions, the teacher would decide the best way for me to carry out the laboratory experiments.	1 2 3 4 5	R ____
28. What I do in laboratory sessions would help me to understand the theory covered in regular physics classes.	1 2 3 4 5	____
29. The teacher would outline safety precautions to me before my laboratory sessions commence.	1 2 3 4 5	____
30. The laboratory would be an attractive place for me to work in.	1 2 3 4 5	____
31. I would work cooperatively in laboratory sessions.	1 2 3 4 5	____
32. I would decide the best way to proceed during laboratory experiments.	1 2 3 4 5	____
33. My laboratory work and regular physics class work would be unrelated.	1 2 3 4 5	R ____
34. My laboratory class would be run under clearer rules than my other classes.	1 2 3 4 5	____
35. My laboratory would have enough room for individual or group work.	1 2 3 4 5	____

สภาพแวดล้อมที่เป็

SUPPLEMENT A

Physics Laboratory Environment Inventory (PLEI)

(Thai Version)

แบบสำรวจสภาพแวดล้อมของห้องปฏิบัติการฟิสิกส์ของโรงเรียนมัธยมศึกษาในประเทศไทย

ชื่อ...เลขที่..........................ชั้นมัธยมศึกษาปีที่ 6/....................

โรงเรียน...ตำบล................................ ..อำเภอ.................................

จังหวัด....................................เขตการศึกษาที่...............เขตพื้นที่บริหารการศึกษาที่..................

ประเภทโรงเรียน (...) โรงเรียนรัฐบาล (...) โรงเรียนเอกชน (...) โรงเรียนสาธิต (...) โรงเรียนสาธิตบาลี

คำชี้แจง

1. แบบสอบถามนี้เกี่ยวข้องกับสภาพแวดล้อมที่เป็นสภาพจริงในห้องปฏิบัติการฟิสิกส์ของโรงเรียนมัธยมศึกษา ในประเทศไทย
2. ให้นักเรียนวงกลมล้อมรอบตัวเลขที่ตรงกับความคิดเห็นของนักเรียนมากที่สุดที่เกี่ยวกับสภาพแวดล้อมของห้องปฏิบัติการฟิสิกส์ที่นักเรียนพบเห็นและได้ดำเนินกิจกรรมในการเรียนรู้ระหว่างการปฏิบัติการทดลอง
    1. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นน้อยที่สุด
    2. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นน้อย
    3. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นปานกลาง
    4. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นมาก

5. หมายถึง
นักเรียนมีความคิดเห็นในระดับความคิดเห็นมากที่สุด

3. โปรดแน่ใจว่านักเรียนตอบครบทุกคำถาม ถ้าต้องการเปลี่ยนคำตอบให้ทำเครื่องหมายกากบาททับหมายเลขนั้น แล้ววงกลมล้อมรอบข้ออื่นที่นักเรียมีความคิดเห็นที่เป็นสภาพที่เป็นจริงกว่า
4. บางข้อความในแบบสอบถามนี้อาจมีลักษณะของคำถามที่คล้ายกัน นักเรียนไม่ต้องกังวลเกี่ยวกับคำถามนี้ โดยนัดเรียนสามารถจะตอบแบบสอบถามไปตามสภาพที่นักเรียนมีความคิดเห็นนั้น
5. ไม่มีคำตอบที่ถูกหรือผิด ความคิดเห็นของนักเรียนจากแบบสอบถามนี้จะเป็นส่วนหนึ่งในการนำไปพิจารณาปรับปรุงในการจัดการเรียนการสอนโดยใช้ห้องปฏิบัติการฟิสิกส์สนับสนุนผลการเรียนรู้และการจัดกิจกรรมการเรียนการสอนของอาจารย์ต่อไป

ขอขอบคุณนักเรียนเป็นอย่างยิ่งในการให้ความร่วมมือในการตอบแบบสอบถามอย่างสมบูรณ์ที่สุด

(ต้นสกุล ศานติบูรณ์)

นักศึกษาปริญญาเอก มหาวิทยาลัยเทคโนโลยีเคอร์ติน ประเทศออสเตรเลีย

ข้อที่	*สภาพแวดล้อมที่เป็นจริงของห้องปฏิบัติการฟิสิกส์ในความคิดเห็นของนักเรียนชั้นมัธยมศึกษาปีที่ 6 ของประเทศไทย*	1	2	3	4	5	เฉพาะอาจารย์
1.	นักเรียนสามารถทำงานร่วมกับเพื่อนในชั้นเรียนได้เป็นอย่างดี	1	2	3	4	5	
2.	นักเรียนได้รับโอกาสที่จะดำเนินการทดลองตามที่ตนเองมีความสนใจ	1	2	3	4	5	
3.	กิจกรรมในห้องปฏิบัติการที่นักเรียนดำเนินการอยู่ไม่สัมพันธ์กับเนื้อหาวิชา	1	2	3	4	5	
4.	มีระเบียบและกฎเกณฑ์ที่ชัดเจนในการแนะนำนักเรียนในการดำเนินกิจกรรม	1	2	3	4	5	
5.	จำนวนนักเรียนมีมากเกินไปในการร่วมกิจกรรมการทดลองในห้องปฏิบัติการ	1	2	3	4	5	
6.	นักเรียนขาดโอกาสที่จะร่วมดำเนินกิจกรรมการทดลองกับเพื่อนร่วมกลุ่ม	1	2	3	4	5	
7.	นักเรียนต้องออกแบบกิจกรรมการเรียนด้วยตัวเองเพื่อ	1	2	3	4	5	

8. 9. 10	แก้ปัญหาที่ได้รับมา กิจกรรมในการทดลองที่กำลังดำเนินการไม่สัมพันธ์กับเนื้อหารตามที่เรียนมา ห้องปฏิบัติการฟิสิกส์ขาดระเบียบในการใช้เครื่องมือเพื่อดำเนินการทดลอง มีเครื่องมือและอุปกรณ์อย่างเพียงพอต่อนักเรียนทั้งชั้นเพื่อใช้ในการทดลอง	1 1 1	2 2 2	3 3 3	4 4 4	5 5 5	
11 12 13 14 15	เพื่อน ๆ ร่วมกลุ่มให้ความช่วยเหลือนักเรียนด้วยดีระหว่างการทดลอง ในปัญหาเดียวกัน นักเรียนได้รับข้อมูลที่แตกต่างจากเพื่อนเพื่อแก้ปัญหานั้น เนื้อหาที่เรียนมามีความสัมพันธ์กับการทดลองในห้องปฏิบัติการฟิสิกส์ นักเรียนต้องปฏิบัติตนอย่างเคร่งครัดตามระเบียบของการใช้ห้องปฏิบัติการ นักเรียนมีความรู้สึกละอายต่อสภาพแวดล้อมของห้องปฏิบัติการที่นักเรียนเห็น	1 1 1 1 1	2 2 2 2 2	3 3 3 3 3	4 4 4 4 4	5 5 5 5 5	
16 17 18 19 20	นักเรียนมีความสนิทสนมกับเพื่อน ๆ ร่วมกลุ่มเป็นอย่างดี นักเรียนได้รับโอกาสดำเนินกิจกรรมต่าง ๆ ด้วยตนเองนอกจากเรียนพร้อมเพื่อน นักเรียนสามารถนำเนื้อหาในชั้นเรียนมาใช้ได้จริงในห้องปฏิบัติการ นักเรียนมีความรู้สึกปลอดภัยในการดำเนินกิจกรรมต่าง ๆ ในห้องปฏิบัติการ สภาพของปฏิบัติการไม่มีระเบียบต่อการเก็บรักษาและการนำไปใช้	1 1 1 1 1	2 2 2 2 2	3 3 3 3 3	4 4 4 4 4	5 5 5 5 5	
21 22 23 24 25	เพื่อน ๆ ให้ความช่วยเหลือนักเรียนด้วยดีเมื่อนักเรียนประสบปัญหา นักเรียนได้รับโอกาสที่สามารถดำเนินการทดลองที่แตกต่างจากเพื่อน ๆ การจัดกิจกรรมการทดลองมีความแตกต่างจากเนื้อหาที่เรียนมา ห้องปฏิบัติการไม่มีระเบียบหรือกฎเกณฑ์ที่ดีต่อการจัดกิจกรรมการเรียนรู้ สภาพห้องปฏิบัติการไม่เหมาะสมทั้งแสง อากาศ หรือมีความแออัดเกินไป	1 1 1 1 1	2 2 2 2 2	3 3 3 3 3	4 4 4 4 4	5 5 5 5 5	
26 27	นักเรียนต้องใช้เวลาเพื่อที่จะทำความรู้จักเพื่อน ๆ ในกลุ่มเพื่อร่วมกันอภิปราย อาจารย์เป็นผู้กำหนดกิจกรรมการเรียนรู้ทั้งหมดโดยไม่	1	2	3	4	5	

	เปิดโอกาสให้นักเรียนมีส่วนร่วม	1	2	3	4	5	
28	การทดลองเป็นกิจกรรมการเรียนรู้ที่มีส่วนสนับสนุนให้นักเรียนเรียนรู้ที่ดีขึ้น	1	2	3	4	5	
29	กฎเกณฑ์ในการใช้ห้องปฏิบัติการไม่มีความแน่นอนที่จะยึดถือต่อการทดลอง	1	2	3	4	5	
30	นักเรียนให้ความสนใจในการที่ใช้ห้องปฏิบัติการนอกเวลาในชั้นเรียนเพื่อดำเนินกิจกรรมตามที่ตนเองให้ความสนใจหรือต้องการแก้ปัญหา	1	2	3	4	5	
31	นักเรียนให้ความร่วมมือต่อเพื่อน ๆ ที่จะดำเนินกิจกรรมการทดลองจนประสบความสำเร็จ	1	2	3	4	5	
32	นักเรียนมีโอกาสที่จะเลือกดำเนินกิจกรรมการทดลองด้วยตนเองตามที่สนใจ	1	2	3	4	5	
33	กิจกรรมการทดลองต่าง ๆ ไม่สัมพันธ์กับเนื้อหาที่เรียนมาในชั้นเรียน	1	2	3	4	5	
34	ระเบียบหรือกฎเกณฑ์ต่าง ๆ มีความเคร่งครัดเมื่อเปรียบเทียบกับห้องปฏิบัติการของวิชาอื่น	1	2	3	4	5	
35	ห้องปฏิบัติการมีความพร้อมทั้งเครื่องมือ อุปกรณ์และสภาพแวดล้อมที่น่าเรียน	1	2	3	4	5	

สภาพแวดล้อมที่พึงประ		SUPPLEMENT B

Physics Laboratory Environment Inventory (PLEI)
(Thai Version)

แบบสำรวจสภาพแวดล้อมของห้องปฏิบัติการฟิสิกส์ของโรงเรียนมัธยมศึกษาในประเทศไทย

ชื่อ...เลขที่...........................ชั้นมัธยมศึกษาปีที่ 6/....................

โรงเรียน...ตำบล..............................

..อำเภอ.................................

จังหวัด.....................................เขตการศึกษาที่..............เขตพื้นที่บริหารการศึกษาที่..................

ประเภทโรงเรียน (...) โรงเรียนรัฐบาล (...) โรงเรียนเอกชน (...) โรงเรียนสาธิต (...) โรงเรียนสาธิตบาลี

คำชี้แจง

1. แบบสอบถามนี้เกี่ยวข้องกับสภาพแวดล้อมที่เป็นสภาพจริงในห้องปฏิบัติการฟิสิกส์ของโรงเรียนมัธยมศึกษา ในประเทศไทย
2. ให้นักเรียนวงกลมล้อมรอบตัวเลขที่ตรงกับความคิดเห็นของนักเรียนมากที่สุดที่เกี่ยวกับสภาพแวดล้อมของห้องปฏิบัติการฟิสิกส์ที่นักเรียนพบเห็นและได้ดำเนินกิจกรรมในการเรียนรู้ระหว่างการปฏิบัติการทดลอง
    1. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นน้อยที่สุด
    2. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นน้อย
    3. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นปานกลาง
    4. หมายถึง นักเรียนมีความคิดเห็นในระดับความคิดเห็นมาก

5. หมายถึง
นักเรียนมีความคิดเห็นในระดับความคิดเห็นมากที่สุด

3. โปรดแน่ใจว่านักเรียนตอบครบทุกคำถาม ถ้าต้องการเปลี่ยนคำตอบให้ทำเครื่องหมายกากบาททับหมายเลขนั้น แล้ววงกลมล้อมรอบข้ออื่นที่นักเรียมีความคิดเห็นที่เป็นสภาพที่เป็นจริงกว่า
4. บางข้อความในแบบสอบถามนี้อาจมีลักษณะของคำถามที่คล้ายกัน นักเรียนไม่ต้องกังวลเกี่ยวกับคำถามนี้ โดยนัดเรียนสามารถจะตอบแบบสอบถามไปตามสภาพที่นักเรียนมีความคิดเห็นนั้น
5. ไม่มีคำตอบที่ถูกหรือผิด ความคิดเห็นของนักเรียนจากแบบสอบถามนี้จะเป็นส่วนหนึ่งในการนำไปพิจารณาปรับปรุงในการจัดการเรียนการสอนโดยใช้ห้องปฏิบัติการฟิสิกส์สนับสนุนผลการเรียนรู้และการจัดกิจกรรมการเรียนการสอนของอาจารย์ต่อไป

ขอขอบคุณนักเรียนเป็นอย่างยิ่งในการให้ความร่วมมือในการตอบแบบสอบถามอย่างสมบูรณ์ที่สุด

(ต้นสกุล ศานติบูรณ์)

นักศึกษาปริญญาเอก มหาวิทยาลัยเทคโนโลยีเคอร์ติน ประเทศออสเตรเลีย

ข้อที่	สภาพแวดล้อมที่พึงประสงค์ที่นักเรียนต้องการให้มีขึ้นในห้องปฏิบัติการฟิสิกส์ในความคิดเห็นของนักเรียนชั้นมัธยมศึกษาปีที่ 6 ของประเทศไทย	1	2	3	4	5	เฉพาะอาจารย์
1.	นักเรียนควรจะสามารถทำงานร่วมกับเพื่อนในชั้นเรียนได้เป็นอย่างดี	1	2	3	4	5	
2.	นักเรียนควรจะได้รับโอกาสที่จะดำเนินการทดลองตามที่ตนเองมีความสนใจ	1	2	3	4	5	
3.	กิจกรรมในห้องปฏิบัติการที่นักเรียนดำเนินการอยู่ควรจะไม่สัมพันธ์กับเนื้อหาวิชา	1	2	3	4	5	
4.	ควรจะมีระเบียบและกฎเกณฑ์ที่ชัดเจนในการแนะนำนักเรียนในการทดลอง	1	2	3	4	5	
5.	ควรจะมีจำนวนนักเรียนมากในการร่วมกิจกรรมการทดลองในห้องปฏิบัติการ	1	2	3	4	5	
6.	นักเรียนควรจะขาดโอกาสที่จะร่วมดำเนินกิจกรรมการทดลองกับเพื่อนร่วมกลุ่ม	1	2	3	4	5	
7.	นักเรียนควรจะออกแบบกิจกรรมการเรียนด้วยตัวเองเพื่	1	2	3	4	5	

8. 9. 10	อแก้ปัญหาที่ได้รับมา กิจกรรมในการทดลองที่กำลังดำเนินการควรจะไม่สัมพั นธ์กับเนื้อหารตามที่เรียน ห้องปฏิบัติการฟิสิกส์ควรจะขาดระเบียบในการใช้เครื่อ งมือเพื่อดำเนินการทดลอง ควรจะมีเครื่องมือและอุปกรณ์อย่างเพียงพอต่อนักเรียน เพื่อใช้ในการทดลอง	1 1 1	2 2 2	3 3 3	4 4 4	5 5 5	
11 12 13 14 15	เพื่อน ๆ ร่วมกลุ่มควรจะให้ความช่วยเหลือนักเรียนด้วยดีระหว่า งการทดลอง ในปัญหาเดียวกัน นักเรียนได้รับข้อมูลที่แตกต่างจากเพื่อนเพื่อแก้ปัญหา นั้น เนื้อหาที่เรียนมาควรจะมีความสัมพันธ์กับการทดลองใ นห้องปฏิบัติการฟิสิกส์ นักเรียนควรจะปฏิบัติตนอย่างเคร่งครัดตามระเบียบขอ งการใช้ห้องปฏิบัติการ นักเรียนควรจะมีความรู้สึกละอายต่อสภาพแวดล้อมขอ งห้องปฏิบัติการที่พบเห็น	1 1 1 1 1	2 2 2 2 2	3 3 3 3 3	4 4 4 4 4	5 5 5 5 5	
16 17 18 19 20	นักเรียนควรจะมีความสนิทสนมกับเพื่อน ๆ ร่วมกลุ่มเป็นอย่างดี นักเรียนควรจะได้รับโอกาสดำเนินกิจกรรม ด้วยตนเองนอกจากเรียนพร้อมเพื่อน นักเรียนควรจะสามารถนำเนื้อหาในชั้นเรียนมาใช้ได้จ ริงในห้องปฏิบัติการ นักเรียนควรจะมีความรู้สึกปลอดภัยในการดำเนินการ ทดลอง ในห้องปฏิบัติการ สภาพของปฏิบัติการควรจะไม่มีระเบียบต่อการเก็บรักษ าและการนำไปใช้	1 1 1 1 1	2 2 2 2 2	3 3 3 3 3	4 4 4 4 4	5 5 5 5 5	
21 22 23 24 25	เพื่อน ๆ ควรจะให้ความช่วยเหลือนักเรียนด้วยดีเมื่อนักเรียนปร ะสบปัญหา นักเรียนควรจะได้รับโอกาสที่สามารถดำเนินการทดลอ งที่แตกต่างจากเพื่อน ๆ การจัดกิจกรรมการทดลองควรจะมีความแตกต่างจากเ นื้อหาที่เรียนมา ห้องปฏิบัติการไม่มีระเบียบหรือกฎเกณฑ์ที่ดีต่อการจัด กิจกรรมการเรียนรู้ สภาพห้องปฏิบัติการควรจะไม่เหมาะสมทั้งแสง อากาศ หรือมีความแออัดเกินไป	1 1 1 1 1	2 2 2 2 2	3 3 3 3 3	4 4 4 4 4	5 5 5 5 5	
26 27	นักเรียนควรจะใช้เวลาเพื่อที่จะทำความรู้จักเพื่อน ๆ ในกลุ่มเพื่อร่วมกันอภิปราย อาจารย์ควรจะเป็นผู้กำหนดกิจกรรมการเรียนรู้ทั้งหมด	1	2	3	4	5	

	โดยไม่เปิดโอกาสให้นักเรียนมีส่วนร่วม	1	2	3	4	5	
28	การทดลองควรจะเป็นกิจกรรมการเรียนรู้ที่มีส่วนสนับสนุนให้นักเรียนเรียนรู้ที่ดีขึ้น	1	2	3	4	5	
29	กฎเกณฑ์ในการใช้ห้องปฏิบัติการควรจะไม่มีความแน่นอนที่จะยึดถือ	1	2	3	4	5	
30	นักเรียนควรจะให้ความสนใจในการที่ใช้ห้องปฏิบัติการนอกเวลาในชั้นเรียนเพื่อดำเนินกิจกรรมตามที่ตนเองให้ความสนใจหรือต้องการแก้ปัญหา	1	2	3	4	5	
31	นักเรียนควรจะให้ความร่วมมือต่อเพื่อน ๆ ที่จะดำเนินกิจกรรมการทดลองจนประสบความสำเร็จ	1	2	3	4	5	
32	นักเรียนควรจะมีโอกาสที่จะเลือกการทดลองด้วยตนเองตามที่สนใจ	1	2	3	4	5	
33	กิจกรรมการทดลองต่าง ๆ ควรจะไม่สัมพันธ์กับเนื้อหาที่เรียนมาในชั้นเรียน	1	2	3	4	5	
34	ระเบียบหรือกฎเกณฑ์ต่าง ๆ ควรจะมีความเคร่งครัดเมื่อเปรียบเทียบกับห้องปฏิบัติการของวิชาอื่น	1	2	3	4	5	
35	ห้องปฏิบัติการควรจะมีความพร้อมทั้งเครื่องมืออุปกรณ์และสภาพแวดล้อม	1	2	3	4	5	

APPENDIX F

Attitude Scale

Part I
Items Sample of Attitude Scale

Please use this scale to answer the following:

1 Almost Always

2 Often

3 Sometime

4 Seldom

5 Almost Never

No.	Attitude Scale	Almost Always	Often	Some times	Seldom	Almost Never
1.	I look forward to lessons in physics subject.	1	2	3	4	5
2.	Lessons in physics subject are fun	1	2	3	4	5
3.	I dislike lessons in physics subject.	1	2	3	4	5
4.	Lessons in physics subject bore me.	1	2	3	4	5
5.	Physics subject is one of the most interesting school subjects.	1	2	3	4	5
6.	I enjoy lesson in physics subject.	1	2	3	4	5
7.	Lessons in physics subject are waste of time.	1	2	3	4	5
8	These lessons make me interested in physics subject	1	2	3	4	5

Items Sample of Attitude Scale
(Thai Version)

แบบสอบถามทัศนคติโดยการให้ทำนายของนักเรียนที่มีต่อการจัดกิจกรรมการเรียนการสอน ในรายวิชาฟิสิกส์ ของโรงเรียนมัธยมศึกษาตอนปลายในประเทศไทย

ข้อที่	*ทัศนคติของนักเรียนที่มีต่อรูปแบบของการมีส่วนร่วมในรายวิชาฟิสิกส์ในประเทศไทย*	ทุก ๆ ครั้ง	บ่อยๆ ครั้ง	บางครั้ง	นานๆ ครั้ง	เกือบไม่เคย
1.	นักเรียนมีความตั้งใจคอยที่จะได้ร่วมกิจกรรมในการเรียนในวิชาฟิสิกส์ในครั้งต่อไป					
2.	การจัดกิจกรรมการเรียนการสอนในรายวิชาฟิสิกส์จะให้ความสนุกสนาน					
3.	นักเรียนมีความรู้สึกไม่ชอบที่จะเรียนวิชาฟิสิกส์ถ้ากิจกรรมกาเรียนการสอนมีลักษณะดังเช่นที่ผ่านมา					
4.	กิจกรรมการเรียนการสอนที่ดำเนินผ่านมาทำให้ฉันมีความรู้สึกเบื่อที่จะร่วมเข้าชั้นเรียน					
5.	วิชาฟิสิกส์เป็นวิชาที่น่าสนใจที่สุดกว่าทุกรายวิชา					
6.	นักเรียนมีความสนุกสนานกับบทเรียนและเนื้อหา ต่าง ๆ ในรายวิชาฟิสิกส์					
7.	นักเรียนมีความรู้สึกว่าการเรียนในรายวิชาฟิสิกส์นี้ทำให้เสียเวลา					
8.	ยิ่งศึกษาหรือให้ความสนใจในรายวิชาฟิสิกส์อย่างละเอียดแล้วทำให้นักเรียนมีความรู้สึกชื่นชอบที่จะเรียนในรายวิชานี้					

Figure 1.1. Educational regions in Thailand (Thaiways web site)

Figure 4.3. The physical classroom learning environment.

Figure 4.4. Interview situation.

seven of the eight scales. The presence of more variation in the majority of the actual teacher interpersonal behaviour than in the majority of the preferred teacher interpersonal behaviour may indicate that students are more agreed about preferred teacher interpersonal behaviour.

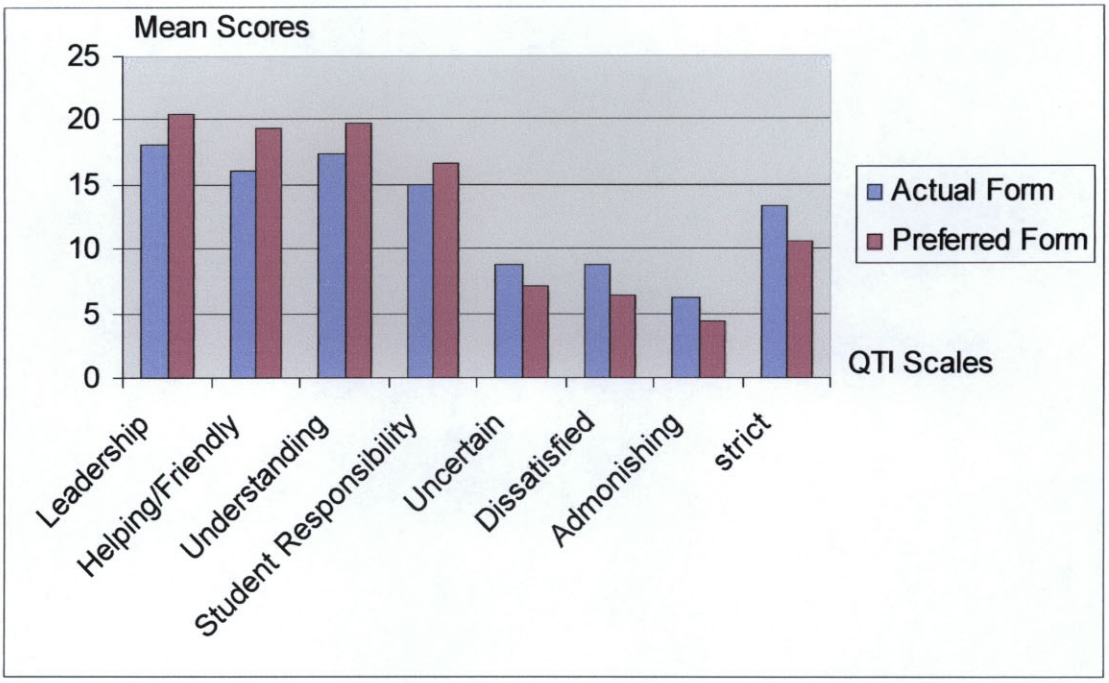

Figure 6.1. Significant differences between students' perceptions of their actual and preferred scores on the QTI.

Figure 6.1 presents a pictorial comparison of the Actual Form with the Preferred Form and indicates that students would prefer more leadership, helping/friendly and understanding behaviours in their teachers and would prefer to be given more responsibility and freedom. However, they would prefer less uncertain, dissatisfied, admonishing and strict behaviours.

The finding also further supports previous related research in that a variety of studies has indicated that students prefer a more positive learning environment than they actually perceive to be present (Fisher, Henderson, & Fraser, 1995; Fisher, Fraser, & Wubbels, 1993; Fisher, Fraser, Wubbels, & Brekelmans, 1993; Fisher & Rickards, 1999; Fisher, Rickards, & Fraser, 1996; Fisher, Rickards, & Newby, 2001; Goh & Fraser,1998; Khine & Fisher, 2001; Koul & Fisher, 2003; Quek, Fraser, & Wong,

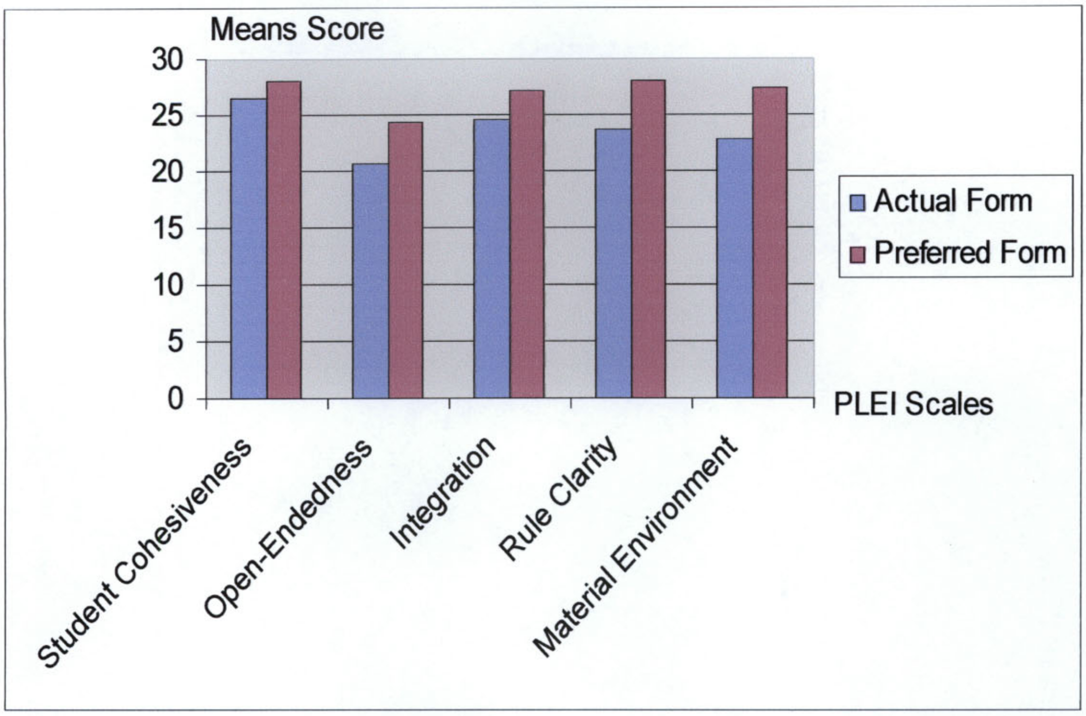

Figure 6.6. Significant differences between students' perceptions of their actual and preferred scores on the PLEI.

6.4 ASSOCIATIONS BETWEEN STUDENTS' PERCEPTIONS OF TEACHERS' INTERPERSONAL BEHAVIOUR AND LABORATORY LEARNING ENVIRONMENT WITH ATTITUDES

There have been a number of studies that have investigated associations between the classroom learning environment and student outcomes (achievement and attitudes) in countries throughout Asia: including Indonesia (Fraser, Pearse, & Azmi, 1982; Schibeci, Rideng, & Fraser, 1987); India (Walberg, Singh, & Rasher, 1977; Koul & Fisher, 2002); Singapore (Fraser & Chionh, 2000); Taiwan (Aldridge & Fraser, 1999) and Brunei (Riah & Fraser, 1998). Each of these studies has suggested that the psychosocial climate of classrooms is an important determinant of student outcomes.

In this study, it was also considered important to investigate associations between students' perceptions of their teachers' interpersonal behaviour and their physics laboratory classroom environments with their attitude toward physics. The selection of an evaluation and assessment instrument suitable for answering the sixth and seventh research questions was required. The internal consistency (Cronbach alpha reliability) of the selected Attitude scale was 0.69, when using individual student as