Science and Mathematics Education Centre

A Cross-National Study of Classroom Environment and Attitudes among Junior Secondary Science Students in Australia and in Indonesia

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ABSTRACT

One purpose of the present study was to validate a modified version of the *What is Happening In This Class?* (WIHIC) questionnaire and the *Test of Science Related Attitude* (TOSRA) in both Australia and Indonesia. It was the first classroom environment study that used the two above questionnaires simultaneously in these two countries. The second aim of this study was to find out whether the scores on the WIHIC questionnaire and TOSRA vary with country and with gender. The third and final aim of this study was to evaluate the strength of the associations between students' perceptions of their classroom environment and their attitude to science in both Australia and Indonesia.

The sample consisted 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 original WIHIC questionnaire had eight scales made up of ten items per scale while the original version of TOSRA had seven scales made up of ten items per scale. Principal components factor analysis followed by varimax rotation resulted in the acceptance of a revised version of the WIHIC comprising 55 items and a revised version of TOSRA comprising 20 items. The *a priori* factor structure of the revised version of each questionnaire was replicated in both countries, with nearly all items having a factor loading of at least 0.30 on their *a priori* scale and no other scale.

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. For example, Australian students had a more positive attitude towards scientific inquiry while Indonesian students had a more positive attitude towards career interest in 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. However, female students had a slightly higher score when it came to career interest in science, student cohesiveness and equity.

A series of simple correlation and multiple regression analyses revealed reasonably strong and positive associations between each classroom environment scale and the attitude scale. Overall Teacher Support and Involvement were the strongest independent predictors of student attitudes to science in both Indonesia and Australia.

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ACRONYMS

CEI	Class Environment Inventory
CES	Classroom Environment Scale
CIPQ	Classroom Interaction Patterns Questionnaire
CLEQ	Cultural Learning Environment Questionnaire
CLES	Constructivist Learning Environment Survey
CUCEI	College and University Classroom Environment Inventory
DOLES	Distance and Open Learning Environment Scale
ICEQ	Individualized Classroom Environment Questionnaire
LEI	Learning Environment Inventory
MCI	My Class Inventory
QTI	Questionnaire on Teacher Interaction
SLEI	Science Laboratory Environment Inventory
S.OR.T	Science Orientation Test
TOSRA	Test of Science-Related Attitudes
WIHIC	What Is Happening In This Class?

Chapter 1

RATIONALE FOR THE STUDY

1.1 INTRODUCTION

This chapter provides a rationale for the present study under the following headings:

- Purpose of the study (Section 1.2);
- Historical perspectives on the field of the classroom learning environments (Section 1.3);
- Science education in Indonesia (Section 1.4);
- Science education in Australia (Section 1.5);
- Significance of the study (Section 1.6);
- Overview of thesis (Section 1.7); and
- Conclusion (Section 1.8)

As we enter the new millennium, we are making good progress in the areas of science and technology. There is a need not only for a larger proportion of talented, well-educated people to fill science-related positions in government and industry, but also for all citizens to be scientifically literate in order to lead rewarding and successful lives (Aldridge & Fraser, 2000).

In his presidential address at the annual meeting of the National Association for Research in Science Teaching (NARST), Fraser (1996) claimed that educational research that crosses national boundaries offers much promise for generating new insights for the following two main reasons:

1. There is greater variation in variables of interest (e.g. teaching methods and student attitudes) in a sample drawn from multiple countries than from a one-country sample.

2. The taken-for-granted familiar educational practices, beliefs and attitudes in one country can be exposed, made 'strange' and questioned when a researcher conducts research involving teaching and learning in two countries. Such research not only provides researchers with an understanding of science education in another country, but also sharpens insights into science education in their own country.

Despite this potential value, there appears to be very few past studies that compare the classroom environments in Australia with those in neighbouring countries of Southeast Asia (Aldridge & Fraser, 2000). Therefore, the present study is unique because of its focus on both Australia and Indonesia.

1.2 PURPOSE OF THE STUDY

This study sought answers to the three following research questions:

Research Question #1

*Is it possible to validate English and Indonesian versions of the WIHIC (*What Is Happening In This Class?*) questionnaire and TOSRA (*Test of Science-Related Attitudes*) for use in Australia and Indonesia?*

In a recent study, Aldridge and Fraser (2000) validated an English and a Mandarin version of WIHIC for use in Taiwan. In this present study, an English and an Indonesian version of WIHIC and TOSRA were validated and used in both Australia and Indonesia.

Research Question #2

*Do students' scores on the WIHIC (*What is Happening in This Class?*) questionnaire and TOSRA (*Test of Science-Related Attitudes*) vary with:*

(a) country (Indonesia and Australia)

(b) gender?

Because Australia and Indonesia are different, for reasons given above, it was anticipated that students' scores on both the WIHIC and TOSRA would show some differences. Over the last few years, Australian girls have been doing better than Australian males in the Senior Science Examinations so, once again, students' scores from both WIHIC and TOSRA could show whether gender differences exist in students' perceptions of their classroom environment and students' attitudes to science in the two countries under investigation (i.e. Australia and Indonesia).

Research Question #3

What is the strength of the associations between students' perceptions of their classroom environment and their attitudes to science in Australia and in Indonesia?

Past research, which is reviewed in the next chapter, has shown that students who have positive perceptions of their classroom environment usually develop positive attitudes to science. As the two questionnaires, *What Is Happening In This Class*? (WIHIC) and *Test of Science-Related Attitude* (TOSRA), were administered simultaneously to measure students' perceptions of their classroom environment and students' attitudes to science, the researcher was able to investigate the strength of the associations between these two types of variables.

1.3 HISTORICAL PERSPECTIVES ON THE FIELD OF CLASSROOM LEARNING ENVIRONMENTS

The notion that a distinct classroom environment exists begun as early as the 1930s, when Kurt Lewin (1936) recognised that the environment and its interactions with personal characteristics of the individual are determinants of human behaviour. Following Lewin's work, Murray (1938) proposed a Needs-Press Model in which situational variables in the environment account for a degree of behavioural variance.

Stern's (1970) Person-Environment Congruence Theory, based on Murray's Needs-Press Model, proposes that more congruence between personal needs and environmental press leads to enhanced outcomes. Also, following Murray's Needs-Press Model, Getzels and Thelen (1960) put forward a model for the class as a social system that suggests that the interaction of personality needs, expectations and the environment predicts behaviours, including students' outcomes. Walberg (1981) proposed a multi-factor psychological theory of educational productivity, which holds that students' learning is a function of three student aptitude variables (age, ability, and motivation), two instructional variables (quantity and quality of instruction) and four psychological environments (the home, classroom, peer group and mass media environments).

The work of Lewin and Murray has provided a strong theoretical base that has influenced contemporary research into classroom environments. The assessment of perceptions has been reflected in the work of these pioneers and, more recently, Murray's Needs-Press Model of interaction has been used to identify the situational variables in this model (Anderson & Walberg, 1974; Moos, 1974; Rentoul & Fraser, 1979). In the late 1960s, two instruments were developed which pioneered the use of perceptions to measure the classroom environment. The Learning Environment Inventory (LEI), developed by Herbert Walberg (Anderson & Walberg, 1968), and the Classroom Environment Scale (CES), developed by Rudolf Moos (Moos & Houts, 1968), paved the way for the development of the subsequent instruments which are described below.

In fact, a milestone in the historical development of the field of learning environments occurred over 30 years ago when Herbert Walberg and Rudolf Moos began their seminal independent programs of research. Walberg developed the Learning Environment Inventory (LEI) as part of the research and evaluation activities of Harvard Physics Project (Walberg, 1979; Walberg & Anderson, 1968), whereas Moos developed social climate scales for various human environments including the Classroom Environment Scale (Moos, 1979; Moos & Trickett, 1987).

A historical look at the field of the learning environment over the past few decades shows that a striking feature is the availability of a variety of economical, valid and widely-applicable questionnaires for assessing student perceptions of classroom environments (Fraser, 1998a, 1998b). These instruments include the Individualised Classroom Environment Questionnaire (ICEQ) for open or individualised settings (Fraser, 1990), the Science Laboratory Environment Inventory (SLEI) for laboratory classroom settings (Fraser, Giddings & McRobbie, 1995), the College and University Classroom Environment Inventory (CUCEI) for higher education classrooms (Fraser & Treagust, 1986), the Questionnaire on Teacher Interaction (QTI) for assessing the interpersonal relationships between teachers and students (Wubbels & Levy, 1993) and the Constructivist Learning Environment Survey (CLES) for assessing the degree to which a particular classroom environment is consistent with constructivist epistemology (Taylor, Fraser & Fisher, 1997), and the Culturally Sensitive Learning Environment Questionnaire (CLEQ) developed by Waldrip and Fisher (1997) for assessing cultural differences between students' perceptions of classroom environment in different countries. Past instruments used to assess the learning environment are discussed in more detail in Chapter 2.

The field of the learning environment is now well established in science education (Aldridge & Fraser, 2000). One of the 10 sections of the 72-chapter *International Handbook of Science Education* (Fraser & Tobin, 1998) is devoted to this topic, as is one of 19 chapters in Gabel's (1994) *Handbook of Research on Science Teaching and Learning*. Learning environments also constitute a section in Anderson's (1996) *International Encyclopaedia of Teaching and Teacher Education* and are a basis for numerous entries in Husen and Postlethwaite's (1994) *International Encyclopedia of Education*. Also the recently-initiated *Learning Environments Research: An International Journal* is devoted exclusively to this topic (Fraser, 1998c).

Although the use of questionnaires has led to many insights into science learning environments through the students' eyes, the field also includes many fine studies that have used qualitative as well as quantitative methods (Fraser, 1998a). Considerable progress has been made in combining qualitative and quantitative methods in learning environment research (Fraser & Tobin, 1991; Tobin & Fraser, 1998). Examples of studies that highlight the benefits of combining qualitative and quantitative methods in learning environment research include: research on exemplary science teachers (Fraser & Tobin, 1989); a study of higher-level learning (Tobin, Kahle & Fraser, 1990); an interpretative study of a teacher-researcher teaching science in a challenging school setting (Fraser, 1999); and a cross-cultural study of science classrooms in Taiwan and Australia (Aldridge & Fraser, 2000).

Literature reviews trace the considerable progress in the conceptualisation, assessment and investigation of the subtle but important concept of the learning environment over the previous quarter of a century (Fraser, 1994, 1998a; Fraser & Walberg, 1991). For example, the varied types of past research on the learning environment in science education include: (1) investigations of associations between student outcomes and classroom environment (McRobbie & Fraser, 1993; Wong, Young & Fraser, 1997); (2) evaluation of educational innovations and systemic reform (Fraser, Kahle, & Scantlebury, 1999; Maor & Fraser, 1996); (3) investigation of differences between students' and teachers' perceptions of experienced and perceived learning environments (Fisher & Fraser, 1983a, 1983b); (4) studies of changes in learning environments during the transition from primary to high school (Ferguson & Fraser, 1999); (5) teachers' practical attempts to improve their own classroom environments (Thorp, Burden & Fraser, 1994); and (6) incorporation of educational environments ideas into the work of school psychologists (Burden & Fraser, 1993).

1.4 SCIENCE EDUCATION IN INDONESIA

Science education in Indonesia has undergone major reforms since independence in 1945. For the past 30 years, the Indonesian government has implemented a series of five-year development plans to achieve the government's goal of having the nation prepared for an era of industrialisation (Penick & Amien, 1992). To achieve this goal, Indonesia must have a workforce with adequate scientists and engineers with skills to enable individual expansion. This goal places a very clear focus on science education and, in particular, Indonesia's current science curricula and science textbooks, as well as the ability of the Indonesian science educators to keep abreast of the rapid developments in modern science and technology (Thair & Treagust, 1997).

With a population of nearly 210 million people distributed unevenly among 26 provinces, Indonesia has perhaps the most centralised education system in the world. Consequently, with headquarters in the country's capital, Jakarta (which is located in Java, the most populated region), there are considerable communication and transportation problems to overcome in order to serve this large growing population distributed over such a wide geographical area.

An important element in the reform of science education in Indonesian secondary schools was the introduction of a new curriculum in 1975. But the problems of identifying and locating appropriate instructional materials and lesson planning was left entirely to teachers (Thomas, 1991). As a result, many teachers were inadequately prepared to initiate learning strategies in order to realise fully the instructional objectives of the new curriculum, and they continued to use traditional teacher-centred 'chalk and talk' learning methods (Thomas, 1991).

During the implementation phase of the 1975 curriculum, training courses were given to principals, administrators and teachers (Penick & Amien, 1992). For teachers, this training had three separate components: the science content of the curriculum; the use of scientific apparatus to carry out experiments; and the methodology involved in producing activity-based lessons in the classroom. Training was conducted in central locations for several weeks and, as a low-cost strategy for disseminating this information, they adopted a 'cascade' model in which these teachers were then expected to return to their schools and conduct further training courses at regional centres for local teachers (Thomas, 1991). However, results of this approach to teacher development in the late 1970s were disappointing (van den Berg & Wilardjo, 1986) and, in spite of the focus on practical activities in the training sessions, the majority of school laboratories remained under-utilised (Pieterz, 1982).

In response to this problem, the Ministry of Education and Culture drew up guidelines for a new training approach and, in 1979, a United Nations Development Plan (UNDP) and the United Educational Scientific and Cultural Organisation (UNESCO) assisted in setting up a training project. This project led to the development of the Pemantapan Kerja Guru (PKG) (strengthening the work of teacher) system of in-service training in Indonesia (Pieterz, 1982). The major purpose of the PKG initiative was to overcome the resilience of teachers to student-centred learning (Thair & Treagust, 1997).

Initially in 1979, 12 teachers were selected as inservice PKG instructors, and they began a 12-week overseas training program that covered subject content, practical work, classroom methodology, and teacher training methodology (Somerset, 1988). One improvement element of training was the production of student activity worksheets, which were later prepared centrally in Indonesia. The worksheet was pivotal to the induction of teachers into an activity-oriented methodology, and formed the core of the PKG induction program. On their return to Indonesia, the role of the PKG instructors was to induct teachers so that they would be ready for the PKG approach of active participation. A number of PKG instructors were selected for study overseas at the Master's degree level. Teaching staff from the overseas universities provided consultancies in Indonesia by visiting schools, working with PKG instructors and attending national science education workshops (Monk & Dillon, 1995).

The implementation and practice of PKG in Indonesia reflect the influence of developments occurring in science education in industrialised centres. However, unlike the approach taken since independence by countries such as Malaysia (Lee, 1992; Tan, 1991), the Indonesian Government did not take the initial approach of adopting and/or adapting an existing outside curriculum. Rather, at the outset, key personnel were provided with intensive inservice education at an overseas centre. Teachers were actively involved at a number of levels in the PKG process, and the work appears to have fostered a sense of ownership among teachers (Thair & Treagust, 1997).

Further, the robustness of the PKG system is demonstrated by the fact that it has persisted through two curriculum reforms during 1984 and 1994. Therefore, the adoption of the PKG approach in science teaching has placed the Indonesian education system in a strong position to meet the challenges of preparing the workforce with the skills required to enable industrial expansion (Thair & Treagust, 1997).

1.5 SCIENCE EDUCATION IN AUSTRALIA

Australia, like Indonesia, is a very big country. While in Indonesia the educational system is centralised, in Australia, each of the six states has its own educational system. In all the states, however, the educational system is made up of the following levels:

- Pre-school for children between the age of 3-5 years
- Kindergarten for children between the age of 5-6 years
- Infants (Years 1-3) for children between the age of 7-8 years
- Primary (Years 4-6) for children between the age of 9-10 years
- Lower Junior Secondary (Years 7-8)
- Upper Junior Secondary (Years 9-10)
- Senior Secondary (Years 11-12)
- University.

Because of Australia's historical link with Britain, science curricula in Australia were originally modelled upon British ideas. The mechanism of change was either to prepare materials that reflected overseas ideas or to adapt overseas materials. In many cases, these ideas and materials were brought into Australia by science educators from overseas or they were generated from within by such influential educators as Wyndham (New South Wales), Radford (Queensland) and Vickery (Western Australia). From the mid-1960s onwards, Australian science education turned away from the traditional British model to those of the United States where the post-sputnik curricula, developed with massive injections of funds by very talented teams of educators, produced materials that could not be ignored (Dekkers, De Laeter & Malone, 1986). For instance, in New South Wales, students at the present moment go through six stages.

In Stages 1 to 3, science in New South Wales is incorporated in the Science and Technology K-6 syllabus. The study of Science and Technology in years K-6 is intended to develop students' competence, confidence and responsibility through their experiences with the science and technology framework. Students learn about the natural world and man-made environment by investigating, designing and making, and using technology. Technology in this syllabus is concerned with the purposeful and creative use of resources in an effort to meet perceived needs or goals.

The Stage 4-5 science syllabus in New South Wales recognises differing needs by providing a structure that all teachers can use to plan learning experiences to encourage positive attitudes towards lifelong learning in science. The syllabus also provides the necessary foundation for the development of knowledge and understanding, skills, value and attitudes for the Stage 6 courses.

The study of Science in Stages 4 and 5 develops students' scientific knowledge and understanding, skills, values and attitudes within broad areas of science that encompass the traditional disciplines of physics, chemistry, biology and the earth sciences. As well as acquiring scientific knowledge and skills, students apply their understanding to everyday life and develop an appreciation of science as a human activity. Students learn about the need to conserve, protect and maintain the environment, the use and importance of technology in advancing science, and the role of science in developing technology. Students also develop an appreciation of, and skills in, selecting and using resources and systems to solve problems. Students with special education needs are eligible to receive the School Certificate by entering a Special Program of Study. In science, this course of study focuses on developing a student's knowledge and understanding of the physical environment, the living environment and people's interaction with these environments.

At Stage 6, students may elect to study one or more courses in a specific science area, an integrated science course or no science at all. The science courses offered in Stage 6 recognise that students could take different pathways beyond Stage 6: some continue with further study in science, some continue with further study in other areas, and others move on to the workforce. The science courses offered in Stage 6 include physics, chemistry, biology, and earth and environmental science, as well as an integrated science course. The subject matter of these courses recognises the different needs and interests of students by providing a structure that builds upon the foundation laid in Stage 5 and yet recognises that students entering Stage 6 have a wide range of abilities, circumstances and expectations. As Stage 5 marks the end of compulsory science education for students in New South Wales, it is important that all students are provided with the opportunity to be scientifically literate by the end of this stage. At the end of Stage 6 courses, students should be able to apply their understanding of science to evaluate critical products, claims and situations that have a scientific or technological basis.

The education system and science education in Western Australia (the second Australian State where my study was carried out) is similar to that in New South Wales. The Curriculum Council, Western Australia (1988) has developed a *Curriculum Framework* which sets out what all students should know, understand, value and be able to do at each school grade level from Kindergarten to Year 12. It provides a structure around which schools can build their educational programs to ensure that students achieve agreed outcomes.

Science is one of eight identified learning areas. The learning outcomes for science are Working Scientifically (investigating, communicating scientifically, science in daily life, acting responsibly, and science in society) and Understanding Concepts (earth and beyond, energy and change, life and living, and natural and processed materials) for example, the 'investigating' outcome is defined as: "Students investigate to answer questions about the natural and technological world using reflection and analysis to prepare a plan; to collect, process and interpret data; to communicate conclusions; and to evaluate their plan, procedures and findings" (Curriculum Council, Western Australia, 1998, p. 220).

1.6 SIGNIFICANCE OF THE STUDY

There are several reasons why this study is important and distinctive. First, whether we are considering science education in Australia or in Indonesia, science educators in both countries value students who have positive perceptions of their classroom environments and exhibit positive attitudes to science. These science educators anticipate that such students will not only perform well in their school years in this particular subject, but will also continue to go on to further studies in some area of science. In turn, this could help them to make important and worthwhile contributions to the society in which they decide to live and work (whether Australia, Indonesia or another country).

The second reason why this study is important for teachers in both countries is that it could help them to become aware of the factors that affect the perceptions of students to their classroom environments, as well as the effect that these factors have on the formation of the attitudes of these students to this particular area of the school curriculum.

The third reason why the researcher chose this study is that there have been many Indonesian and Asian students who are studying in Australia. Therefore, it would be useful for Australian educators to better understand the cultural differences between the two countries, namely, Australia and Indonesia, and whether these differences have any effect on the way in which high school students perceive their classroom environments and develop their attitudes to science. Knowledge of any differences, or similarities, between both perceptions of classroom environments and attitudes to science by the two sexes, in these two countries, could prove helpful in course selection, counselling and developing positive interpersonal relationships between teachers and students.

1.7 OVERVIEW OF THESIS

Chapter 1 has outlined the rationale for the study and has introduced the research questions. Chapter 2 reviews the literature pertaining to the field of the classroom learning environment in both Western countries and non-Western countries and reviews literature pertaining to past research on students' attitude to science. Chapter 3 describes the methods used in the present study and gives reasons for the choice of countries for this cross-national study, for the choice of grade level and for the choice of the student sample. Chapter 4 gives a detailed report of the analysis and results of the study. Chapter 5 presents the conclusions to this study while, at the same time, pointing out both the limitations and suggesting future lines of research.

1.8 CONCLUSION

Past research suggests that, to make the science teaching-learning process more successful in Australia, Indonesia and elsewhere, it is desirable that students, particularly junior secondary students, are provided with positive classroom environments, which have been found to be linked with positive attitudes to science (Fraser, 1998a).

The present study attempts to answer some crucial research questions about the associations of male and female students' perceptions of their classroom environment and their attitudes to science in two neighbouring countries, namely, Australia and Indonesia, with widely different historical, religious and cultural characteristics.

The first objective of this study was to validate English and Indonesian versions of the *What Is Happening In This Class*? (WIHIC) questionnaire and the *Test of Science-Related Attitudes* (TOSRA) for use in Australia and Indonesia. The second main objective was to investigate the differences between Australian students and Indonesian students in terms of their perceptions of their classroom environment and their attitudes to science. The third objective of this study is to investigate the associations between student perceptions of the classroom learning environment and students' attitude to science. The fourth objective is to investigate sex differences on students' perceptions of their classroom environment and from these students their attitude to science.

This study is important and unique because it is the first study carried out in Indonesia for which both the WIHIC (*What Is Happening In This Class*?) questionnaire and TOSRA (*Test of Science-Related Attitudes*) have been administered simultaneously in both Indonesia and Australia after first having been translated from English to Bahasa Indonesia and then back-translated into English (Brislin, 1970). This study is also unique in that it is one of very few cross-national studies involving investigation of the same research questions simultaneously in two different countries.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

The major purpose of the present study was to investigate the relationship between students' perceptions of their classroom environment and their attitudes to science in two culturally-different countries, namely, Australia and Indonesia.

This chapter reviews literature related to the present study under eight sections:

- Definition of key terms and concepts used in this thesis (Section 2.2);
- Research approaches for investigating classroom environments (Section 2.3);
- Unit of statistical analysis (Section 2.4);
- Pioneering research on classroom environment (Section 2.5);
- Learning environment instruments (Section 2.6);
- Attitude-measuring techniques and instruments (Section 2.7);
- Past research on classroom environment in Western countries (Section 2.8);
- Past research on classroom environment in non-Western countries (Section 2.9); and
- Cross-national studies of classroom environment (Section 2.10).

2.2 DEFINITION OF KEY TERMS AND CONCEPTS

As a number of key terms and concepts are used in this thesis, this section defines and explains key terms and concepts.

2.2.1 Concept of Learning Environment

The word 'environment' has many facets of meanings. In the context of the classroom, it could be defined as the "shared perceptions of the students and sometimes the teachers in that environment" (Fraser, 1986a, p. 1). Broadly, there are two aspects of the classroom environment, namely, the physical environment and the human environment. The physical environment includes the material setting of the classroom, such as furniture, lighting and the layout of the objects in the classroom. The human environment includes the students and the teacher in that classroom and their interaction with each other. Therefore, the human environment refers to the psychosocial climate of the classroom. This is the aspect of the classroom environment in which teachers, as facilitators of learning, could play an important part in making it more conducive for their students' learning. It is also this aspect of the classroom environment which classroom researchers are interested in examining. Studies have shown that effective learning is related to a positive classroom environment (e.g. Brophy & Putnam, 1979).

2.2.2 Concept of Attitude

The concept of attitude was important in the present study, which explored the influence of the classroom environment on student attitudes. The definition and measurement of attitudes have been widely explored in books such as by Eiser (1984), Mueller (1986) and Lemon (1973). "Attitudes cannot be observed or measured directly. Their existence must be inferred from their consequences" (Mueller, 1986, pp. 1-2). Given that attitude is a non-observable psychological construct whose presence can only be deduced from the behaviour manifested, it is thus not surprising that there is no unanimous agreement amongst social scientists on any given definition for the term 'attitude'. For instance, Thurstone, the social psychologist who first formulated and popularised the methodology for measuring attitude, defined attitude as "the sum total of a man's inclination and feelings, prejudice and bias, preconceived notions, ideas, fears, threats, and convictions about any specified topic" (Thurstone, 1928, p. 531). However, Thurstone modified the definition of attitude to be "the effect for or against a psychological object" (Thurstone, 1931, p. 261). In a later year, he commented that he wished that he had kept to his draft definition of 'attitude' in his, 1928 paper, namely, "the intensity of positive or negative effect for or against a psychological object" (Thurstone, 1946, p. 39). This is a narrower definition of attitude.

Other definitions of attitude include "a mental or neural state of readiness" (Allport & Hartman, 1935, p. 810), "consistency in response to social objects" (Campbell, 1950,

p. 31), and the "the covert response evoked by a value" (Linton, 1945, pp. 111-112). The notion that attitudinal behaviour is learned and could be further modified is widely accepted by social scientists. Also acknowledged by researchers and educators are the relationship of attitudes to values and beliefs and its impact on the human psyche. Some recent studies of students' attitudes in science include McRobbie and Fraser (1993), Soerjaningsih, Fraser and Aldridge (2002) and Quek, Fraser and Wong (2002).

2.3 RESEARCH APPROACHES FOR INVESTIGATING CLASSROOM ENVIRONMENTS

There are several approaches to research on classroom environments (Fraser, 1986a, 1994, 1998a). One approach is the use of an external observer to record the happenings (e.g. events and interactions) in the classroom (e.g. Dunkin & Biddle, 1974; Rosenshine & Furst, 1973). This 'objective' approach can be contrasted with the 'subjective' approach, which requires the use of the students' and teachers' perceptions of their classroom environments. The distinction between these two approaches in the measurement of the environments has been widely acknowledged in the psychological literature (see Jessor & Jessor, 1973). Furthermore, the 'objective' approach and 'subjective' approach correspond, respectively, to Murray's (1938) terms of *alpha press* (perceptions of the detached observer) and *beta press* (perceptions of the milieu inhabitants). Some advantages in using perceptual measures of students over observations made by outside observers have been highlighted by

Fraser and Walberg (1981). For nearly a quarter of a century, most classroom environment studies had involved the use of the perceptions of students and teachers (e.g. see Fisher, 1994; Fraser, 1984, 1985, 1986b, 1987, 1988, 1989, 1994, 1998a; Fraser & Walberg, 1991; Goh & Khine, in press; MacAuley, 1990).

Assessment of classroom environments could be based on explicit observations or on judgements based on the interpretations of observations by outside observers. The former are termed 'low-inference' measures and the latter 'high-inference' measures by Rosenshine (1970).

Another approach for researching classroom environment involves qualitative methods such as ethnography. Vivid descriptions of the human interactions within the classroom and schools are presented in popular books, such as: *High School* (Boyer, 1983); *Inside High School: The Student's World* (Cusick, 1973); *Life in Classrooms* (Jackson, 1968); *A Place Called School* (Goodlad, 1984); *After the School Bell Rings* (Grant & Sleeter, 1996); and *Fifteen Thousand Hours: Secondary Schools and Their Effect on Children* (Rutter, Maughan, Mortimore, Outon & Smith, 1979).

Other approaches to studying human environments outlined by Moos (1973) involve ecological dimensions, behaviour settings and personal characteristics of the occupants of the environment concerned. Ecological dimensions consist of meteorological and geographical dimensions, and physical design and architectural features such as those reviewed by Weinstein (1979). Behavioural settings include the moral behaviour and the ecological domain in which it occurs, as featured in the work of Barker and Gump (1964). The approach which focuses on the personal characteristics of the occupants of the environment derives its characteristics from those members in the environment concerned, and the prevalent characteristics of the environment depend on the typical characteristics of its members (e.g. Astin & Holland, 1961).

Kaye, Tricket and Quinlan (1976) reported the use of multiple methods of assessment of the same classroom environment. Two classroom environment characteristics, namely, teacher support and teacher control, were measured using three different environment assessment methods. These included: student perceptual measures, as assessed by some of the scales in the *Classroom Environment Scale* (Moos & Trickett, 1987); global ratings by outside observers; and the observation and categorisation of interaction within the classroom. The findings showed apparent convergent validity for the different methods. Studies by Greene (1983) and Schell (1984) revealed similar patterns. Schell's study, besides confirming the presence of statistically significant relationships between student perceptions and direct observations, highlighted the uniqueness of each method of study and its distinct contribution to the assessment of the classroom environment.

Recent research approaches taken in classroom environment studies have incorporated both qualitative and quantitative methods (see Fraser & Tobin, 1991; Tobin & Fraser, 1998). Fraser and Tobin (1989) adopted this approach in a study of 22 exemplary teachers and a group of non-exemplary teachers. The research design predominantly involved interpretative research methods, which included classroom observation, interviewing of students and teachers and the construction of case studies. The use of qualitative information was complemented by the use of quantitative information, namely, students' perceptual measures of the psychosocial classroom environment. The study suggested that exemplary and non-exemplary teachers can be distinguished in terms of the psychosocial environment, and that exemplary teachers tend to create and maintain environments that are distinctly more favourable than those of non-exemplary teachers (Fraser & Tobin, 1989). Other classroom environment studies using a combination of qualitative and quantitative methods include: research into the elusive goal of higher-level cognitive learning by Tobin, Kahle and Fraser (1990); a multilevel teacher-researcher study of determinants of classroom environment (Fraser, 1999; Fraser & Hoffman, 1995); another multilevel classroom environment study by Waxman, Huang and Wang (1996); and a cross-national study of classroom climate in Taiwan and Australia (Aldridge & Fraser, 2000; Aldridge, Fraser & Huang, 1999; Huang & Fraser, 1997).

2.4 UNIT OF STATISTICAL ANALYSIS

Stern, Stein and Bloom (1956) distinguished between the individual view, which each milieu inhabitant has of the environment (*private beta press*), and the common view which group members have of the environment (*consensual beta press*). These two terms are extensions of Murray's (1938) distinction between *alpha press* (the environment as noted by an outside observer) and *beta press* (the environment as experienced by the milieu inhabitants). The discussion below examines the importance of the choice unit of statistical analysis for research.

Fraser (1986a, 1994, 1998a) discussed the importance of the choice of an appropriate unit or level of statistical analysis. Firstly, by using different units of statistical analysis, measures with the same operational definition could have different interpretations. Secondly, there is the possibility of obtaining different relationships, in terms of the size and sign of the relationship, for different units of statistical analysis (Robinson, 1950). Thirdly, the possibility of sampling error could occur (Peckham, Glass & Hopkins, 1969; Ross, 1978) with the use of different units of statistical analysis. Lastly, different hypotheses are tested with the use of different units of statistical analysis (Burstein, Linn & Capell, 1978).

Concern for the suitability of the unit of statistical analysis has resulted in the use of hierarchical analysis of data (Bryk & Raudenbush, 1992; Burstein, 1978; Burstein, Linn & Capell, 1978; Cronbach & Snow, 1977; Cronbach & Webb, 1975; Larkin & Keeves, 1984; Lincoln & Zeitz, 1980) and multilevel of analysis (Bock, 1989; Goldstein, 1987). However, Sirotnik (1980) pointed out the absence of consideration of the unit of analysis when validating new instruments.

Thus, in designing research on classroom environment, the researcher must decide on the unit of statistical analysis, especially whether the study will involve the perceptual scores of individual students (*private beta press*) or the averaged scores of all students within the same class (*consensual beta press*) (Stern, Stein, & Bloom, 1956).

2.5 PIONEERING RESEARCH ON CLASSROOM ENVIRONMENT

Pioneering work, together with contemporary studies and current research, on learning environments have been documented in several major reviews (e.g. Fraser, 1986b, 1991, 1994, 1998a).

Lewin (1936) and Murray (1938) and their followers, such as Pace and Stern (1958), were in the vanguard of human environment studies. The formula, $B = f(P, E)$ was part of the pioneering work of Lewin (1936) and it reflected his acknowledgement that human behaviour within an environment is determined both by the characteristic features of the people in it and by the characteristics of the environment itself

In line with Lewin's endeavour, Murray (1938) proposed a model of 'needs-press', which incorporates the notion of the behaviour of the person to realise their goals (personal needs) and the positive or negative impact of the environment (environmental press) on their personal needs.

Over 30 years ago, Herbert Walberg and Rudolf Moos conducted separate pioneering research on learning environment. In conjunction with the research and the evaluation of Harvard Project Physics (Walberg & Anderson, 1968), Walberg developed the

Learning Environment Inventory (LEI). Moos' initial development of social climate scales for various types of environments, including psychiatric hospitals and correctional institutions, led to the evolution of the Classroom Environment Scale (CES) (Moos, 1979; Moos & Trickett, 1987). Major research developments in the area of classroom environment, arising from the pioneering work of Walberg and Moos, have been documented in: books (e.g. Fraser, 1986a; Fraser & Walberg, 1991; Goh & Khine, in press; Moos, 1979; Walberg, 1979); literature reviews (e.g. Anderson & Walberg, 1974; Chavez, 1984; Fraser, 1985, 1998a; MacAuley, 1990; von Saldern, 1992; Walberg, 1976); monographs (e.g. Fraser, 1981a; Fraser & Fisher, 1983a); guest-edited journal issues (e.g. Fraser, 1980a; McRobbie & Ellett, 1997); an annotated bibliography (e.g. Moos & Spinrad, 1984); and in the editor's introduction of a new international journal, entitled *Learning Environments Research* (Fraser, 1998c).

Rosenshine (1970) distinguished between the terms 'low-inference' and 'high-inference' measures of the classroom environment. Low-inference measures refer to the specific reporting of explicit observations, whereas high-inference measures refer to assessment based on deduction from observations. Chavez (1984) observed that low-inference measures were present in social psychological studies as early as the 1920s. For example, Thomas (1929) implemented techniques to document the overt social behaviours of nursery school children, and Lewin, Lippit and White (1939) studied the influence of three types of leadership (democratic, autocratic, and laissez-faire) on the group of behaviours of boys aged between 10 and 11 years (interaction, aggression and productivity). Reviews of earlier studies using low-inference measures of classroom environment are given in Dunkin and Biddle (1974) and Peterson and Walberg (1979).

2.6 CLASSROOM ENVIRONMENT INSTRUMENTS

This section describes historically significant and contemporary classroom environment instruments (Section 2.6.1), some other classroom environment instruments (Section 2.6.2), and school environment instruments (Section 2.6.3). Also included is a description of different forms and versions of classroom environment instruments (Section 2.6.4).

2.6.1 Historical and Contemporary Classroom Environment Instruments

Table 2.1, adapted from Fraser (1994), shows a list of nine historically-important and contemporary classroom environment instruments for use at the secondary and post-secondary school levels, with their scales categorised according to Moos' classification of human environments. Moos' dimensions are: Relationship; Personal Development; System Maintenance; and System Change. Relationship dimensions refer to the kind and strength of the personal relationships in the environment, the degree of people's involvement in the environment and the assistance given to each other. Personal Development dimensions measure the fundamental path of personal growth and self-enrichment. System Maintenance and System Change Dimensions measure the degree of orderliness, control and responsiveness to change in the environment.

This subsection briefly describes each of the following classroom environment instruments: *Learning Environment Inventory* (LEI); *Classroom Environment Scale* (CES); *Individualised Classroom Environment Questionnaire* (ICEQ); *My Class Inventory* (MCI); *College and University Classroom Environment Inventory* (CUCEI); *Questionnaire on Teacher Interaction* (QTI); *Science Laboratory Environment Inventory* (SLEI); *Constructivist Learning Environment Survey* (CLES); and *What Is Happening In This Class?* (WIHIC) questionnaire.

The *Learning Environment Inventory* (LEI), as mentioned earlier in Section 2.5, was developed by Walberg in the 1960s, in connection with the assessment and research related to Harvard Project Physics (Fraser, Anderson & Walberg, 1982; Walberg & Anderson, 1968). The final version consists of 105 statements in 15 scales, namely: Cohesiveness; Friction; Favouritism; Cliqueness; Satisfaction; Apathy; Speed; Difficulty; Competitiveness; Diversity; Formality; Material Environment; Goal Direction; and Disorganisation (seven items per scale). The four responses are: Strongly Disagree; Disagree; Agree; and Strongly Agree. For some items, the scoring direction is reversed.

Table 2.1 Dimensions Contained in Nine Classroom Environment Instruments

Instrument	Level	Items Per Scale	Scales Classified According to Moos' Scheme: Relationship Dimensions	Personal Development Dimensions	System Dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisation
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order and Organisation Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation 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	Personalisation Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualisation
Questionnaire on Teacher Interaction (QTI)	Secondary	8	Leadership Understanding Helping/ Friendly Freedom/ Responsibility Uncertain Dissatisfied Admonishing Strict		
Science Laboratory Environment Inventory (SLEI)	Upper Secondary Higher Education	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Constructivist Learning Environment Survey (CLES)	Secondary	6	Personal Relevance Uncertainty	Critical Voice Shared Control	Student Negotiation
What Is Happening In This Class? (WIHIC)	Secondary	10	Student Cohesiveness Teacher Support Involvement	Investigation Cooperation	Equity Task Orientation

*Adapted from Fraser (1994)

Rudolf Moos (Fisher & Fraser, 1983a; Moos, 1979; Moos & Trickett, 1987) developed the *Classroom Environment Scale* (CES). This instrument is the product of a wide array of research covering perceptual measures of human environments of psychiatric hospital, prisons, university residences and work areas. The final version has 90 items in nine scales, namely: Involvement; Affiliation; Teacher Support; Task Orientation; Competition; Order and Organisation; Rule Clarity; Teacher Control; and Innovation (10 items per scale). The response format is either True or False.

The *Individualised Classroom Environment Questionnaire* (ICEQ) measures dimensions pertaining to the individualised classroom (namely: Personalisation; Participation; Independence; Investigation; and Differentiation) as opposed to those of the conventional classroom. It has both actual and preferred versions and either students or teachers can use it. Furthermore, Rentoul and Fraser (1979) and Fraser (1980b) discuss a short version of the long form ICEQ at great length. The final version (Fraser, 1990) comprises 50 items in five scales (10 items per scale). The five possible responses are: Almost Never; Seldom; Sometimes; Often; and Very Often. The scoring direction is reversed for many of the items.

The *My Class Inventory* (MCI) is a simplified version of the LEI. It is for students aged 8-12 years (Fisher & Fraser, 1981; Fraser, Anderson & Walberg, 1982; Fraser & O'Brien, 1985). The MCI takes into consideration the attention span (and hence the fatigue factor) among young children and their language proficiency. In fact, students with reading comprehension difficulties could use the MCI at higher grade levels. The final version has 38 items in five scales. The distribution of the items is: six for Cohesiveness; eight for Friction; nine for Satisfaction; eight for Difficulty; and seven for Competitiveness. The response format is either Yes or No. A variation of this response format was used by Goh, Young and Fraser (1995), consisting of: Seldom; Sometimes; and Most of the Time. Recently, the MCI was used in a study in Brunei (Majeed, Fraser & Aldridge, in press).

The *College and University Classroom Environment Inventory* (CUCEI) was developed for 'seminar' classes at the college and university level (Fraser & Treagust, 1986; Fraser, Treagust & Dennis, 1986). The final version has 49 items in seven scales, namely: Personalisation; Involvement; Student Cohesiveness; Satisfaction; Task Orientation; Innovation; and Individualisation (seven items per scale). The four possible responses are: Strongly Agree; Agree; Disagree; and Strongly Disagree. The scoring direction for half of the items is reserved.

Wubbels, Créton and Hooymayers (1985), based on the work of Leary (1957), developed the *Questionnaire on Teacher Interaction* (QTI) in the Netherlands. This study into the characteristics of the interpersonal relationships between teachers and students in the Netherlands involved evaluation of students' perception of eight facets of teacher behaviour, namely: Helpful/Friendly; Understanding; Dissatisfied; Admonishing; Leadership; Student Responsibility and Freedom; Uncertain; and Strict behaviour, (Créton, Hermans & Wubbels, 1990; Wubbels, Brekelmans & Hooymayers, 1991; Wubbels & Levy, 1993). The response alternatives range from

Never to Always on a five-point scale (namely, 0 to 4). The original version of the QTI has 77 items (Wubbels, Créton & Hooymayers, 1985). Following this, an American version, with 64 items (Wubbels & Levy, 1993), and then an Australian version, with 48 items (Goh & Fraser, 1996), were developed.

The QTI has been cross-validated at different grade levels in the USA (Wubbels & Levy, 1993), Australia (Fisher, Henderson & Fraser, 1995), Singapore (Goh & Fraser, 1996), Brunei (Riah, Fraser, & Rickards, 1997) and Indonesia (Soerjaningsih, Fraser & Aldridge, 2002). Ever since its inception, the QTI has undergone modifications. For example, Goh and Fraser (1996) developed and validated a 48-item version of the QTI for use at the primary school and Cresswell and Fisher (1997) developed the Principal Interaction Questionnaire (PIQ), based on the QTI, to measure teachers' perceptions of school principals on the same eight dimensions of the interaction between the principal and his/her teachers (see also Fisher & Cresswell, 1996). Some examples of relatively recent classroom environment research involving the use of the QTI include: a study of the professional development of teachers (Fisher, Fraser & Cresswell, 1995); research in secondary science classrooms (Fisher, Goh, Wong & Rickards, 1996); the assessment of teacher-student interpersonal relationships in mathematics classrooms (Fisher, Rickards & Fraser, 1996; Rickards & Fisher, 1996); the investigation of sex differences in biology students' perceptions of teacher-student relationships (Henderson, Fisher & Fraser, 1995a); associations between learning environments and student outcomes (Henderson, Fisher & Fraser, 1995b); the relationship between teacher personality and interpersonal teacher behaviour (Kent, Fisher & Fraser, 1995); and the relationship between science students' perceptions of their teacher's interpersonal behaviour, students' cultural environment and students' preferred student-teacher interpersonal behaviour (Waldrip & Fisher, 1996). The QTI has been used in Singapore (Goh & Fraser, 1998), Brunei (Riah & Fraser, 1998) and Indonesia (Soerjaningsih, Fraser & Aldridge, 2002).

The *Science Laboratory Environment Inventory* (SLEI) was developed to measure the distinct learning environment of the science laboratory classroom (Fraser, Giddings & McRobbie, 1995; Fraser & McRobbie, 1995; Fraser, McRobbie, & Giddings, 1993). There are 35 items in five scales, namely: Student Cohesiveness; Open-Endedness; Integration; Rule Clarity; and Material Environment (seven items per scale). The five responses are: Almost Never; Seldom; Sometimes; Often; and Very Often. The SLEI was field-tested and validated in different countries such as the USA, Canada, England, Israel, Australia and Nigeria. It was also cross-validated in Australia (Fisher, Henderson & Fraser, 1997; Fraser & McRobbie, 1995), Korea (Lee & Fraser, 2001) and Singapore (Wong & Fraser, 1995). The SLEI has both Class and Personal Forms of both actual and preferred versions (Fraser, Giddings & McRobbie, 1995).

The *Constructivist Learning Environment Survey* (CLES) was developed by Taylor and Fraser (1991) to measure the extent to which a classroom environment conforms to the constructivist philosophy and to help teachers in their reflections and fine-tuning of their teaching strategies. It was subsequently revised (Taylor, Dawson & Fraser, 1995; Taylor, Fraser & Fisher, 1997; Taylor, Fraser & White, 1994). The revised CLES consists of 30 items in five scales, namely: Personal Relevance; Uncertainty; Critical Voice; Shared Control; and Student Negotiation (six items per scale). The five possible responses are: Almost Never; Seldom; Sometimes; Often; and Almost Always. Examples of recent studies using the CLES are in the evaluation of urban systemic reform (Dryden & Fraser, 1996) and in the study of physics students' epistemologies and views about knowing and learning (Roth & Roychoudhury, 1994). The CLES has been translated into other languages and used in Taiwan (Aldridge, Fraser, Taylor & Chen, 2000) and Korea (Kim, Fisher & Fraser, 1999).

Fraser, Fisher and McRobbie (1996) developed the *What Is Happening In This Class?* (WIHIC) questionnaire. This is a parsimonious learning environment instrument, which incorporates important scales from a wide range of existing learning environment instruments, together with additional scales of current educational concern, such as equity. Just like the *Science Laboratory Environment Inventory* (SLEI), the WIHIC has a separate Class Form and Personal Form. The Class Form measures a student's perception of the class as a whole, while the Personal Form measures a student's perception of their role in the classroom. The original version of the WIHIC had 90 items (nine scales, 10 items per scale) and it was field-tested and fine-tuned to form the second version which contains 80 items in eight scales, namely: Student Cohesiveness; Teacher Support; Autonomy/Independence; Involvement; Investigation; Task Orientation; Cooperation; and Equity (10 items per scale). The five possible responses are: Almost Never; Never; Sometimes; Often; and Almost

Always. The second version was cross-validated in Australia and Taiwan (Aldridge, Fraser, & Huang, 1999). A modified version of the WIHIC has been used in Singapore (Fraser & Chionh, 2000), Canada (Zandvliet & Fraser, 1999), the USA (Allen & Fraser, 2002; Moss & Fraser, 2001) and Indonesia (Soerjaningsih, Fraser & Aldridge, 2002). The WIHIC was chosen for use in my study (see Chapter 3).

2.6.2 Other Classroom Environment Instruments

Besides the learning environment instruments discussed above, there are other instruments, which have been developed for specific purposes. These instruments were developed by drawing upon a combination of existing instruments. There are also other instruments designed with a focus on a specific psychosocial environment. This subsection briefly describes some examples of such instruments.

Dorman, Fraser and McRobbie (1997) developed an instrument for the study of the classroom environment of Catholic schools in Australia. This is a 66-item instrument consisting of seven scales, namely: Student Application; Interaction; Cooperation; Task Orientation; Order and Organisation; Individualisation; and Teacher Control. It was based on the *Classroom Environment Scale* (CES), the *College and University Classroom Environment Inventory* (CUCEI), and the *Individualised Classroom Environment Questionnaire* (ICEQ).

An instrument catering for the reading ability of middle school students was developed by Sinclair and Fraser (1997) to meet the needs of the language proficiency of students in middle schools. The instrument consists of four scales, namely: Cooperation; Teacher Empathy/Equity; Task Orientation; and Involvement. It was based on the *My Class Inventory* (MCI) and the *What Is Happening In This Class?* (WIHIC) questionnaire.

Teh and Fraser (1995a) developed the Geography Classroom Environment Inventory (GCEI) for assessing computer-assisted classroom learning environments in Singapore. This instrument consists of the four scales of: Gender Equity; Investigation; Innovation; and Resource Adequacy. It was based on the *Classroom Environment Scale* (CES), the *College and University Classroom Environment Inventory* (CUCEI), the *Individualised Classroom Environment Questionnaire* (ICEQ), and the *Science Laboratory Environment Inventory* (SLEI). Another instrument (Maor & Fraser, 1996), measuring computer-related learning environments, was based on the LEI, ICEQ and SLEI and was field-tested in Australia.

Idiris and Fraser (1997) drew upon the *Constructivist Learning Environment Survey* (CLES) and the *Individualised Classroom Environment Questionnaire* (ICEQ) to develop an instrument suitable for measuring the learning environment of agricultural science classes in Nigeria. It assesses negotiation, autonomy, student centredness, investigation and differentiation.

Woods and Fraser (1995) developed the *Classroom Interaction Patterns Questionnaire* (CIPQ) to measure students' perceptions of teaching style. The instrument consists of six scales, namely: Praise and Encouragement; Open Questioning; Lecture and Direction; Individual Work; Discipline and Management; and Group Work. This was field-tested in Australia.

Fisher and Waldrip (1997) developed the *Cultural Learning Environment Questionnaire* (CLEQ) to measure culturally-sensitive factors in the learning environment. It measures the perceptions of students on eight scales, namely: Equity; Collaboration; Risk Involvement; Competition; Teacher Authority; Modelling; Congruence; and Communication. This 40-item instrument was based partly on an existing instrument and was field-tested in Australia.

Jegede, Fraser and Fisher (1995) developed the *Distance and Open Learning Environment Scale* (DOLES) for measuring university students' distance education learning achievements. The instrument consists of five main scales, namely: Student Cohesiveness; Teacher Support; Personal Involvement and Flexibility; Task Orientation and Material Environment; and Home Environment. There are also optional scales called *Study Centre Environment* and *Information Technology Resources*. Jegede, Fraser and Fisher (1998) discuss the development, validation, and use of this learning environment instrument for university distance education settings.

2.6.3 Different Forms and Versions of Classroom Environment Instruments

Short Forms of Instruments

Three of the instruments described in Section 2.6.1 also have a corresponding short form: the *Individualised Classroom Environment Questionnaire* (ICEQ), *My Class Inventory* (MCI) and *Classroom Environment Scale* (CES) (Fraser, 1982a; Fraser & Fisher, 1983b). The short forms of the ICEQ and the MCI each comprises 25 items (five scales, five items per scale), whilst the CES consists of 24 items (six scales, four items per scale). The development of the short forms took into consideration the comprehension ability of respondents and also the length of time involved in the administration of the instruments by teachers. Furthermore, it met the need of teachers who would like to hand score the responses of their students.

Actual and Preferred Versions of Environment Instruments

Most classroom environment instruments also have preferred versions. The actual version measures the psychosocial characteristics of the environment as experienced by the student and or the teacher, whilst the preferred version measures the psychosocial characteristics of the environment which the students or the teacher would like to have. The contents of the items of both versions are similar. The only difference is in the use of the conditional tense (namely 'would') for the preferred version. For example, in the *What Is Happening In This Class?* (WIHIC) questionnaire, an item in the actual version, which reads as "Students discuss ideas in class", would be changed in the preferred version to "Students *would* discuss ideas in class".

Class and Personal Forms of Environment Instruments

Fraser and Tobin (1991) saw the need for instruments to differentiate between the perceptions of subgroups (e.g. male and female students) or individuals within the class. They observed that the items in existing instruments at that time are worded to elicit the individual student's perceptions of the class as a whole and not their role in the class. Fraser, Giddings and McRobbie (1995) developed and validated Class and Personal forms of the *Science Learning Environment Inventory* (SLEI). They found that the differences in perceptions between male and female students were somewhat larger on the Personal form than on the Class form. In an investigation of associations between student outcomes and their perceptions of the science laboratory classroom environment, commonality analyses revealed that each form appears to measure different aspects of the science laboratory classroom environment (see also Fraser, McRobbie & Fisher, 1996; McRobbie, Fisher & Wong, 1998).

2.6.4 Concluding Remarks

One of the foci of the present study was to investigate the relationship between classroom environment and student attitudes. Of the existing classroom environment instruments discussed above, the What Is Happening In This Class? (WIHIC) questionnaire was selected for use in the present study because it stands out as a parsimonious instrument that can elicit the 'actual' state of the psychological classroom environment. Also, the WIHIC has proved to be useful, valid and reliable in numerous past studies in several countries. Because one of the major purposes of the present study was to cross-validate the WIHIC questionnaire with a sample from Indonesia, the final version of the WIHIC questionnaire was selected. Also, for the purpose of cross-validation of the WIHIC questionnaire, only the actual version was used.

2.7 ATTITUDE-MEASURING TECHNIQUES AND INSTRUMENTS

As a major aim of the present study was to explore associations between classroom environment and students' attitudes, this section reviews literature about techniques for assessing attitudes. Several scaling techniques have been developed to measure attitudes. Examples include: Likert attitude scaling; Thurstone scaling; Guttman scaling; the semantic differential technique; the *Scientific Orientation Test* (S.OR.T.); and the *Test of Science-Related Attitude* (TOSRA). Each of these tests or techniques is briefly described below.

2.7.1 Likert Scaling Technique

In measuring the attitude of a respondent using the Likert Scaling Technique (Likert, 1932), the researcher locates the respondent's position on a continuum ranging from the extreme end of 'positive' to that of 'negative'. Responses to given statements about an attitudinal object on a five-point continuum (e.g. strongly agree, agree, uncertain, disagree and strongly disagree) are tallied. An example of an attitude measure that uses the Likert scale technique is the Test of Science-Related Attitudes (TOSRA) developed by Fraser (1981a). TOSRA makes use of Klopfer's (1971) classification of students' attitudinal aims. The six categories in Klopfer's classification are: attitude to science and scientists; attitude to inquiry; adoption of scientific attitudes; enjoyment of science learning experiences; interest in science; and interest in a career in science. This instrument has been widely used to measure attitudes related to the study of science (e.g. Fraser & Butts, 1982; McRobbie & Fraser, 1993).

2.7.2 Thurstone Scaling Technique

The Thurstone Scaling Technique for attitude measurement, developed by Thurstone (1927), was based on the method of Allport and Hartman (1925). Three separate but related methods were developed: paired comparisons; equal-appearing intervals; and successive intervals. For paired comparisons (Thurstone, 1927), attitude statements are paired and a judgement has to be given as to which one of the statements is more favourable towards the attitudinal object. This method is rather tedious. The method of equal-appearing interval requires judgements to be made by classifying each statement into equidistant categories ranging from 'extremely unfavourable' to 'extremely favourable' (Thurstone & Chavez, 1929). The method of successive intervals is an extension of the equal-appearing interval method (Saffir, 1937). The difference between the two methods is that the method of successive intervals establishes the intervals statistically, rather than depending on subjective judgement, as is the case for the equal-appearing interval method.

2.7.3 Guttman Scaling Method

The Guttman Scaling Method has response options that are similar to those in Likert and Thurstone scales. The uniqueness of the Guttman scaling technique is that it is non-dimensional. This means that a respondent whose score places them at a particular point on the attitude continuum must agree with all items below (less positive than) this point and must disagree with all items above this point. Total conformity to this condition is difficult in attitude measures, as total consensus amongst respondents to the ordering of statements is difficult to achieve.

2.7.4 Semantic Differential Technique

The development of the Semantic Differential Technique for attitude measurement by Osgood, Suci and Tannenbaum (1957) resulted from investigation of the nature of meaning. Using factor analysis, Osgood identified the underlying dimensions of meaning such as evaluation, potency and activity. Bipolar adjectives, which largely represent the evaluative dimension, are constructed. The respondent selects a response on a seven-point scale along the bipolar adjective continuum (e.g. easy-difficult). The strengths of the Semantic Differential Technique for attitude measurement are that they are usually reliable, relatively easy to construct, and quick to administer. Weaknesses of this technique are encountered when respondents insist on a literal interpretation for some pairs of adjectives and possibly do not respond to the items concerned. Also, the validity of an attitude measure is questionable if respondents 'slant' the answer, as it is easy for respondents to figure out what is being measured. Of the four techniques (Likert, Thurstone, Guttman and the Semantic Differential), the Semantic Differential is the most direct, in that it asks respondents about their attitudes towards a certain object. Also, the staements of the semantic differential are 'transparent' (Mueller, 1986, p. 56).

2.7.5 Scientific Orientation Test (SORT)

A specific attitude instrument that has been used by educators during the last 30-40 years is the Scientific Orientation Test (S.OR.T.) (Meyer, 1995). This test focuses mainly on interests in and attitudes towards science. It was designed to measure a range of affective subjects. While it was especially designed for school Years 7 to 10, it can be used in primary school Years 5 and 6 and in senior secondary school Years 11 and 12.

The test is organised so that an overall measure of Scientific Orientation can be obtained together with a series of 17 sub-scores on specific affective aspects. Two of these are concerned with interest in the non-scientific areas of Literature and Fine Art. An especially useful feature of the test is that each of the subtests is sufficiently valid and reliable in its own right to stand on its own. S.OR.T. has had a long history (since the early 1960s) of use and refinement in Australia and overseas. There is an extensive research literature relating to its development and application. It has been shown to be valid and reliable (Meyer, 1995).

2.7.6 Test of Science-Related Attitude (TOSRA)

Fraser (1978) developed the TOSRA to measure seven distinct science-related attitudes among secondary school students: Social Implications of Science; Normality of Scientists; Attitude to Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science. Each scale contains 10 items, making a total of 70 items for the whole instrument. The five-point Likert scale and has response categories ranging from Strongly Agree to Strongly Disagree. A description of the seven scales, an explanation of each scale according to Klopfer's (1971) classification, and a sample item for each scale is given in Table 2.2.

The TOSRA is actually an extension and an improvement of earlier versions of the following five scales: Social Implications of Science; Attitude to Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; and Leisure Interest in Science. This battery of five attitude scales was field tested with samples of Year 7 students and refined. Then it was extended and improved in the following four ways to evolve a preliminary version of the TOSRA:

Table 2.2 Description of TOSRA Scales

Scale	Klopfer (1971) Classification	Sample Item
Social Implications of Science	Manifestation of favourable attitudes towards science and scientist	Money spent on science is well worth spending. (+)
Normality of Scientists	Acceptance of scientific inquiry as a way of thought	Scientists usually like to go to their laboratories when they have a day off. (-)
Attitude to Scientific Inquiry	Acceptance of scientific attitudes way of thought	I would prefer to find out why something happens by doing an experiment than by being told. (+)
Adoption of Scientific Attitudes	Adoption of 'scientific attitudes'	I am curious about the world in which we live. (+)
Enjoyment of Science Lessons	Enjoyment of science learning experiences	I dislike science lessons. (+)
Leisure Interest in Science	Development of interest in science and science-related activities	I would like to belong to a science club. (+)
Career Interest in Science	Development of interest in pursuing a career in science	I would dislike being a scientist after I leave school. (-)

*Adapted from Fraser (1981a).

Items designated (+) are scored 1, 2, 3, 4, 5, respectively, for the responses strongly disagree, disagree, not sure, agree and strongly agree. Items designated (-) are scored in the reverse manner. Missing or invalid responses are scored 3.

1. Two new scales, Normality of Scientists and Career Interest in Science, were added;
2. The three different sets of administration instructions and answering formats of the previous battery were condensed into a single set of instructions and answering format for the TOSRA;
3. Each TOSRA scale contained the same number of items instead of having a different number of items in each scale, as was the case in the original battery of scales; and

4. The TOSRA was field tested and validated with student samples from all four junior high school grade levels (Years 7-10), rather than just Year 7 alone.

Next, the preliminary version of the TOSRA was commented upon by a group of science teachers and experts in educational measurement. Based on their feedback, the TOSRA was refined further. This interim version, containing 14 items per scale, was field tested with a sample of 1,337 Years 7-10 students in 44 classes from 11 schools in Australia. Following a series of statistical analyses that were performed on the obtained data, a final version of the TOSRA comprising 10 items per scale was evolved. The scales of this refined version were found to display satisfactory internal consistency reliability, test-retest reliability and discriminant validity.

Teachers and researchers have found the TOSRA to be useful and easy to use for measuring and monitoring changes in science-related attitudes of individual students or whole classes of students. For example, it can be used in a pretest-posttest situation to find out if students have changed their science-related attitudes over a period of time, such as a school year. Besides this, the TOSRA also makes it possible for researchers and teachers to obtain a 'profile' of attitude scores for a particular group of students. This is a major advantage that the TOSRA has over other science attitude questionnaires that yield only a single overall score rather than a separate score for a number of distinct attitudinal measures. Due to the characteristics of TOSRA outlined above, the researcher decided to use that instrument to measure students' attitudes to science.

2.8 PAST RESEARCH ON CLASSROOM ENVIRONMENT IN WESTERN COUNTRIES

There has been a large number and variety of classroom environment studies completed in various parts of the world over the past 30 years (Fraser, 1998a). Although the majority of past learning environment studies have been conducted in Western countries, a growing number of studies have been undertaken in non-Western countries. Owing to the relevance to the present study of part research in non-Western countries, separate sections are devoted to:

- past research on classroom environment in non-Western countries (Section 2.9)
- cross-national studies of classroom environment (Section 2.10)

Because studies in non-Western countries are discussed separately in subsequent sections, the literature reviewed in Section 2.8 is restricted to studies conducted in Western countries. In organising this review of past research on classroom learning environment in Western countries, discussion is divided into two subsections:

- Past research in Western countries involving classroom environment dimensions as independent variables (2.8.1); and

- Past research in Western countries involving classroom environment dimensions as dependent variables (Section 2.8.2).

2.8.1 Past Research in Western Countries Involving Classroom Environment Dimensions as Independent Variables

The strongest tradition in past classroom environment research has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classrooms (Fraser & Fisher, 1982; Haertel, Walberg & Haertel, 1981; McRobbie & Fraser, 1993). Numerous research programmes have shown that students' perceptions account for appreciable amounts of variance in learning outcomes, often beyond that attributable to student background characteristics. Table 2.3, based on Fraser (1994), tabulates some studies which show that associations between outcome measures and classroom environment perceptions have been replicated for a variety of cognitive and affective outcome measures, a variety of classroom environment instruments and a variety of samples (ranging across numerous countries and grade levels).

Table 2.3 Some Studies of Associations Between Student Outcomes and Classroom Environment in Western Countries

Study	Outcome Measures	Sample
Studies Involving LEI		
Anderson & Walberg (1968); Walberg & Anderson (1968); Anderson (1970) Walberg (1969, 1972)	Selected from: achievement; understanding of nature of science; science processes; participation in physics activities; science interest; attitudes.	Various samples (maximum of 144 classes) of senior high school physics students mainly in USA, but with some in Canada
Walberg & Anderson (1972)	Examination results	1,600 Grade 10 and 11 students in 64 classes in Montreal Canada
Lawrenz (1976)	Science attitudes	238 senior high school science classes in Midwest USA
Fraser (1978, 1979)	Inquiry skills; attitudes; understanding of nature of science	531 students in 20 Grade 7 science classes in Melbourne, Australia
Power & Tisher (1979)	Achievement; attitudes; satisfaction	315 junior high school students in 20 classes in Melbourne, Australia
Hofstein *et al.* (1979)	Attitudes	400 Grade 11 students in 12 chemistry classes in Israel
Haladyna, Olsen & Shaughnessy (1982)	Attitudes	5,804 science, mathematics and social studies students in 277 Grade 4, 7 and 9 classes in Oregon, USA
Studies Involving CES		
Fisher & Fraser (1983b)	Inquiry skills; attitudes	116 Grade 8 and 9 science classes throughout Tasmania, Australia
Rentoul & Fraser (1980)	Inquiry skills; enjoyment	285 junior high school students in 15 classes in Sydney, Australia
Wierstra (1984)	Attitudes; achievement	398 15-16 year old students in 9 classes in the Netherlands
Fraser (1981b); Fraser & Butts (1982)	Attitudes	Maximum of 712 students in30 junior high school science in Sydney, Australia
Fraser, Nash & Fisher (1983)	Anxiety	116 Grade 8 and 9 science classes throughout Tasmania, Australia
Fraser & Fisher (1982)	Inquiry skills; attitudes	116 Grade 8 and 9 science classes throughout Tasmania, Australia
Studies Involving MCI		
Fraser & Fisher (1982)	Inquiry skills; understanding of nature of science; attitudes	2,305 Grade 7 science students in 100 classes in Tasmania, Australia
Studies Involving Other Instruments		
Talton (1983)	Attitude; achievement	1,456 Grade 10 biology students in 70 classes in 4 schools in North Carolina

*Source: Fraser (1994)

For example, using the SLEI, associations with students' cognitive and affective outcomes have been established for a sample of approximately 80 senior high school chemistry classes in Australia (Fraser & McRobbie, 1995; McRobbie & Fraser, 1993), 489 senior high school biology students in Australia (Fisher, Henderson & Fraser, 1997) and 1,592 Grade 10 chemistry students in Singapore (Wong & Fraser, 1996). Using an instrument suited for computer-assisted instruction classrooms, Teh and Fraser (1995a) established associations between classroom environment, achievement and attitudes among a sample of 671 high school geography students in 24 classes in Singapore. Using the QTI, associations between student outcomes and perceived patterns of teacher-student interaction were reported for samples of 489 senior high school biology students in Australia (Fisher, Henderson & Fraser, 1995), 3,994 high school science and mathematics students in Australia (Fisher, Fraser & Rickards, 1997) and 1,512 primary school mathematics student in Singapore (Goh, Young & Fraser, 1995).

Multilevel Analysis

While many past learning environment studies have employed techniques such as multiple regression analysis, few have sued the multilevel analysis (Bock, 1989; Bryk & Raudenbush, 1992; Goldstein, 1987), which takes cognisance of the hierarchical nature of classroom settings. As classroom environment data are typically derived from students in intact classes, they are inherently hierarchical. Ignoring this nested structure can give rise to problems of aggregation bias (within-group homogeneity) and imprecision.

Two studies of outcome-environment associations compared the results obtained from multiple regression analysis with those obtained from an analysis involving the hierarchical linear model. The multiple regression analyses were performed separately at the individual student level and the class mean level. In the HLM analyses, the environment variables were investigated at the individual level, and were aggregated at the class level. In Wong, Young and Fraser's (1997) study involving 1,592 Grade 10 students in 56 chemistry classes in Singapore, associations were investigated between three student attitude measures and a modified version of the SLEI. In Goh, Young and Fraser's (1995) study with 1,512 Grade 5 mathematics students in 39 classes in Singapore, scores on a modified version of the MCI were related to student achievement and attitude. Most of the significant results from the multiple regression analyses were replicated in the HLM analyses, as well as being consistent in direction.

Meta-Analysis of Studies

The findings from prior research are highlighted in the results of a meta-analysis involving 734 correlations from 12 studies involving 823 classes, eight subject areas, 17,805 students and four nations (Haertel, Walberg & Haertel, 1981). Learning posttest scores and regression-adjusted gains were found to be consistently and strongly associated with cognitive and affective learning outcomes, although correlations were generally higher in samples of older students and in studies employing classes and schools (in contrast to individual students) as the units of statistical analysis. In particular, better achievement on a variety of outcome measures was found consistently in classes perceived as having greater cohesiveness, satisfaction and goal direction and less disorganisation and friction. Other meta-analyses synthesised by Fraser, Walberg, Welch and Hattie (1987) provide further evidence supporting the link between educational environments and student outcomes.

Educational Productivity Research

Psychosocial learning environment has been incorporated as one factor in a multi-factor psychological model of educational productivity (Walberg, 1981). This theory, which is based on an economic model of agricultural, industrial and national productivity, holds that learning is a diminishing-returns function of: student age, ability and motivation; of quality and quantity of instruction; and of the psychosocial environment of the home, the classroom, the peer group and the mass media. Because the function has a multiplying effect, it can be argued in principle that any factor at a zero-point will result in zero learning; thus either zero motivation or zero time for instruction will result in zero learning. Moreover, it will do less good to raise a factor that is already high than to improve a factor that currently is the main constraint to learning. Empirical probes of the educational productivity model were made by carrying out extensive research syntheses involving the correlations of learning with the factors in the model (Fraser, Walberg, Welch & Hattie, 1987; Walberg, 1986) and secondary analyses of large data bases collected as part of the National Assessment of Educational Progress (Fraser, Welch & Walberg, 1986). Classroom and school environment was found to be a strong predictor of both achievement and attitudes even when a comprehensive set of other factors was held constant.

2.8.2 Past Research in Western Countries Involving Classroom Environment Dimensions as Dependent Variables

Evaluation of Educational Innovations

Classroom environment instruments can be used as a source of process criteria in the evaluation of educational innovations (Fraser, Williamson & Tobin, 1987). An evaluation of the Australian Science Education Project (ASEP) revealed that, in comparison with a control group, ASEP students perceived their classrooms as being more satisfying and individualised and having a better material environment (Fraser, 1979). The significance of this evaluation is that classroom environment variables differentiated revealingly between curricula, even when various outcome measures showed negligible differences. Recently, the incorporation of a classroom environment instrument within an evaluation of the use of a computerised database revealed that students perceived that their classes became more inquiry oriented during the use of the innovation (Maor & Fraser, 1996). Similarly, this was also found in two studies in evaluations of computer-assisted learning (Teh & Fraser, 1994) and computer application courses for adults (Khoo & Fraser, 1997). In an evaluation of an urban systemic reform initiative in the USA, use of the CLES painted a disappointing picture in terms of a lack of success in achieving constructivist-oriented reform of science education (Dryden & Fraser, 1996).

Differences Between Student and Teacher Perceptions of Actual and Preferred Environment

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 (1983a) using the ICEQ, with a sample of 116 classes for the 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 ICEQ dimensions. Also, teachers perceived a more positive classroom environment than did their students in the same classroom on four of the ICEQ's dimensions. These results replicate patterns emerging in other studies in school classrooms in the USA (Moos, 1979), Israel (Hofstein & Lazarowitz, 1986), The Netherlands (Wubbels, Brekelmans & Hooymayers, 1991) and Australia (Fraser, 1982b; Fraser & McRobbie, 1995), and in other settings such as hospital wards and work milieus (e.g., Moos, 1974).

Studies Involving Other Independent Variables

Classroom environment dimensions have been used as criterion variables in research aimed at identifying how the classroom environment varies with such factors as teacher personality, class size, grade level, subject matter, the nature of the school-level environment and the type of school (Fraser, 1994). For example, larger class sizes were found to be associated with greater classroom formality and less cohesiveness (Anderson & Walberg, 1972). Kent and Fisher (1997) established associations between teacher personality and classroom environment (e.g., extravert teachers' classes having high levels of Student Cohesiveness).

Several studies have attempted to bring the fields of classroom environment and school environment together by investigating links between classroom and school environment (Fisher, Fraser & Wubbels, 1993; Fisher, Grady & Fraser, 1995; Fraser & Rentoul, 1982). When Dorman, Fraser and McRobbie (1997) administered a classroom environment instrument to 2,211 students in 104 classes and a school environment instrument to 208 teachers of these classes, only weak associations between classroom environment and school environment were found. Although school rhetoric would often suggest that the school ethos would be transmitted to the classroom level, it appears that classrooms are somewhat insulated from the school as a whole.

In a study of students' preferences for different types of classroom environments, girls were found to prefer cooperation more than boys, but boys preferred competition and individualisation more than girls (Owens & Straton, 1980). Similarly, Byrne, Hattie and Fraser (1986) found that boys preferred friction, competitiveness and differentiation more than did girls, whereas girls preferred teacher structure, personalisation and participation more than did boys. Several studies have revealed that females generally hold perceptions of their classroom environments that are somewhat more favourable than the perceptions of males in the same classes (Fisher, Fraser & Rickards, 1997; Fraser, Giddings & McRobbie, 1995; Henderson, Fisher & Fraser, 1995a).

2.9 PAST RESEARCH ON CLASSROOM ENVIRONMENT IN NON-WESTERN COUNTRIES

Although a recent literature review (Fraser, 1998a) shows that the majority of the classroom environment studies undertaken involved Western students, a number of important studies have been carried out in non-Western countries (Goh & Khine, in press). Early studies established the validity of classroom environment instruments that had been translated into the Indian (Walberg, Singh & Rasher, 1977) and Indonesian (Fraser, Pearse & Azmi, 1982; Schibeci, Rideng & Fraser, 1987) languages and replicated associations between student outcomes and classroom environment perceptions. Recently, Asian researchers working in Singapore (Chionh & Fraser, 1998; Fraser & Chionh, 2000; Goh, Young & Fraser, 1995; Quek, Fraser & Wong, 2001; Teh & Fraser, 1994, 1995a, 1995b; Wong & Fraser, 1996), Brunei (Riah & Fraser, 1998), Korea (Kim, Fisher & Fraser, 1999; Lee & Fraser, 2001) and Indonesia (Margianti, Fraser & Aldridge, 2002) have made important contributions to the field of learning environments.

In a study in Brazil, Holsinger (1972) investigated the relationship between students' perceptions of classroom environment and the cognitive outcome of information learning and the non-cognitive outcome of individual modernity. The sample consisted of 2,533 Grade 3 to 5 students in 90 classes in the Federal District of Brasilia, and a composite index of classroom environment was formed by selecting one item from eight scales in a preliminary version of the LEI. It was found that students in classes that were perceived as higher on the composite environment index had higher information and modernity scores, although the meaningfulness of the composite environment index used in Holsinger's research must be questioned.

In a somewhat similar study of primary classrooms in Indonesia, Paige (1978) examined relationships between classroom learning environment and the two outcomes of cognitive achievement and individual modernity. The sample was composed of a stratified random group of sixth grade classes in 30 rural and 30 urban schools in East Java, and classroom environment was measured by an instrument which was based on a translation of some items selected from LEI and CES. Specific findings included the trend that individual modernity was enhanced in classrooms perceived as having greater task orientation, competition, and difficulty and less order and organisation, while achievement was enhanced in classes higher in speed and lower in order and organisation.

In Jamaica, Persaud (1976) studied the effects of classroom environment on non-cognitive outcomes such as social development and aspiration levels. The sample was composed of 1,277 Grade 3 and 6 students in 18 schools. Classroom environment was measured as a composite 'openness' variable based on students', teachers' and principals' scores on various scales in the CES. It was found that perceptions of more open classroom environments were associated with a higher level of student social development.

Chatiyanonda (1978) reported results for a sample of 989 Grade 12 physics students in 31 classes in Bangkok or nearby provinces. Learning environment, measured with a Thai version of 10 of the LEI's scales, was used to predict three attitudinal outcomes (attitude to physics learning, enjoyment of physics, and attitude to scientists). Simple correlation analysis revealed that half of the correlations between one of the 10 LEI scales and posttest scores on one of the three attitude scales were significantly different from zero at the 0.05 level of confidence, which is 10 items that expected by chance at the 0.05 level of confidence. Multiple regression analyses revealed that the increment in posttest attitude variance accounted for by the set of environment scales (beyond that attributable to corresponding beginning-of-year attitude scores and numerous background variables) was significant for two of the three attitude scales. More favourable attitudes to physics learning were expressed in classes perceived as having more cohesiveness, less friction, less cliques and more satisfaction, while greater enjoyment of physics was reported in classrooms characterised as having less speed, more satisfaction, less disorganisation and greater competitiveness.

Walberg, Singh, and Rasher's (1977) study in India involved administration of the 15 LEI scales translated into Hindi to a random sample of 3,000 Grade 10 students in 83 science and 67 social science classes in 26 districts of the State of Rajasthan. The unit of statistical analysis employed was the mean score of the sub-group within the class formed by grouping studious class members together and non-studious class members together. Therefore, the total sample size was 166 science subgroups (83 studious and 83 non-studious) and 134 social science subgroups (67 studious and 67 non-studious). Strong and statistically significant associations between cognitive achievement and student-perceived classroom environment were found.

In Nigeria, Idiris and Fraser (1997) examined the psychosocial environment of agricultural science classrooms. This study reported the cross-cultural validity of classroom environment scales used in Nigeria and replicated research into associations between the classroom environment and student outcomes reported in Western countries.

In Korea, Kim, Fisher and Fraser (1999) investigated the extent to which a new general science curriculum, reflecting a constructivist view, has influenced the classroom learning environment in Grade 10 science. They used the *Constructivist Learning Environment Survey* (CLES) developed by Taylor and Fraser (1991). The CLES was translated into Korean. Other objectives of their study were to investigate whether the Korean version of CLES was valid and reliable for identifying differences between students' perception of their actual and preferred learning environment and to determine associations between students' perceptions of the constructivist learning environment and their attitudes to science. The CLES was administered to 1083 students and 24 science teachers in 12 different schools. One class of Grade 10 students and one class of Grade 11 students were sampled at each school. The numbers of boys and girls were almost the same in each local area, and in each grade.

Each student in the Korean sample responded to the actual and preferred versions of the CLES and to a seven-item attitude scale that was based on the *Test of Science-Related Attitudes* (Fraser, 1981a). The data were analysed to check the *a priori* factor structure of the CLES, internal consistency of each of the scales, discriminant validity and ability to differentiate between classrooms. MANOVA was used to determine whether there were differences in the means of the five scales of the actual and preferred versions between Grade 10 students and Grade 11 students. Calculating the effect sizes (the difference between two means divided by the pooled standard deviation) assessed the educational significance of differences between grades. In this process, an effect size of 0.2 was considered very low, 0.5 medium, 0.7 high and 0.8 very high (Cohen, 1977). Simple and multiple correlation analyses were used to determine whether there were any associations between students' perceptions of their constructivist learning environments and their attitudes to class. The first step in the validation of the CLES involved a series of factor analyses whose purpose was to examine the internal structure of the set of 30 items. A principal components analysis with varimax rotation was used to generate orthogonal factors. As the instrument was designed with five scales, a five-factor solution was considered.

The alpha reliability coefficient was used as the index of scale internal consistency, while the mean correlation of a scale with the other four scales was used as a convenient index of scale discriminant validity. With the individual student as the unit of analysis, the alpha reliability ranged from 0.64 to 0.87 for the actual form and from 0.79 to 0.91 for the preferred form. This suggested that all scales of the Korean version of the CLES possess satisfactory internal consistency.

The mean correlation of one scale with the other four scales ranged from 0.24 to 0.38 for the actual form and from 0.44 to 0.50 for the preferred form. These values confirmed the discriminant validity of CLES, indicating that each scale measures a distinct, although somewhat overlapping, aspect of the classroom environment.

To find out whether the CLES was capable of differentiating between the perceptions of students' in different Korean classrooms, a one-way ANOVA was used, with class membership as the main effect. Students within the same class should have relatively similar perceptions of their classroom environment, while mean within-class perceptions should vary from class to class. It was found that each CLES scale differentiated significantly ($p<0.01$) between classes and that the eta^2 statistic, representing the proportion of variance explained by class membership, ranged from 0.05 to 0.13. These figures are relatively low and suggest that the learning environment of most science classes is quite similar in Korea. Most science teachers teach their students according to textbooks that have a close relationship with the national curriculum in Korea. Thus most of the textbooks have similar content and structure. This might be one of the reasons for the existence of similar learning environments across science classes in Korea (Kim, Fisher & Fraser, 1999).

Differences in students' perceptions of their learning environment between Grade 10 and Grade 11 were explored using a one-way MANOVA with the set of CLES scales as dependent variables. Because the Wilks' lambda criterion was found to be statistically significant ($p<0.05$), a corresponding one-way ANOVA was examined for each of the CLES scales. Results showed that Grade 10 students perceived their environment as more constructivist for most scales except uncertainty, and that the differences were statistically significant ($p<0.01$) for the three scales of personal relevance, shared control and student negotiation.

Associations between the five actual CLES scales and students' attitudes towards their science class were examined using multiple regression analysis involving the whole set of the CLES scales, in addition to a simple correlation analysis, to provide a more conservative test of associations between each CLES scale and attitude when all other CLES scales were mutually controlled. Examination of the simple correlation coefficients indicated that there were statistically significant relationships ($p<0.05$) between students' perceptions of the learning environment and their attitudes towards the science class for most scales of CLES. Students' perceptions showed a statistically significant correlation with their attitudes for the scales of personal relevance, shared control, and student negotiation for Grade 11. Multiple correlations were also statistically significant ($p<0.01$) for both Grade 10 and Grade 11 students. An examination of beta weights revealed that personal relevance was the strongest independent predictor of students' attitudes towards their science class.

In another investigation of science classroom environments in Korea, Lee and Fraser (2001) focused on two aspects, namely, constructivism and the interaction pattern between students and teachers. Their study made use of two questionnaires (*Constructivist Learning Environment Survey*, CLES, and *Questionnaire on Teacher Interactions*, QTI) after a rigorous translation procedure. Analyses of the survey data, collected by using the QTI and CLES, suggested that the Korean versions of the CLES and QTI have satisfactory reliability and validity for all scales when used in Korean high schools. From the survey with the CLES, it was revealed that science lessons 'sometimes' conveyed the notions of constructivism. This suggested that active implementation of constructivism in practice by teachers has been supported by various bodies (i.e., Ministry of Education, Science Teachers' Associations, etc.). The survey results also replicated the study by Kim, Fisher and Fraser (1999) and provided further support for the reliability and validity of CLES in Korea.

In Japan, Hirata and Sako (1999) constructed scales to assess Japanese school environments. These scales were based on the *Classroom Environment Scale* (CES) (Moos & Trickett, 1974) and a Japanese scale (Hirata, 1994). Hirata, Sako and Koizumi (1994) developed a new scale to assess the school environment and compared junior high school students and non-attendant students on that scale. The original scale consisted of 61 items, with 41 items from the CES (Moos, 1974), which had shown higher factor loading in several factor analyses in previous studies (Hirata & Sako, 1999). Several items were taken from each of the nine scales of the CES, namely: Involvement; Affiliation; Teacher Support; Task Orientation; Competition; Order and Organisation; Rule Clarity; Teacher Control; and Innovation. In addition, 20 items were taken from the Japanese scale (Hirata, 1994): five items for Teacher Support; six items for Sense Isolation; three items for Rule Clarity; three items for Difficulty of Achievement; and three items for Rule Strictness. The study was made up of two parts. The first part of this study involved characteristics of three public schools and one private school.

The original scale was administered to 635 junior high school students (365 males and 270 females). Of these, 132 boys and 134 girls were from three public junior high schools and 233 boys and 136 girls were from a private junior high school.

Factor analysis (principal components with varimax rotation) revealed four factors from the 61 items: Teacher Control; Sense of Isolation; Order and Discipline; and 'WA' affiliation, including 29 items used to form the *Classroom Environment Scale* (CES-J). The term 'WA' in Japanese means harmony among people and is an essential concept in Japanese society because the Japanese think that cooperation and modesty are virtues. They also think that drifting away or quitting a group is a very serious situation in Japanese society. The results were analysed using analysis of variance (ANOVA), with the CES-J as the dependent variable and the different schools as the independent variable. As no statistically significant gender differences were found for any factor, male and female data were combined. The data were analysed using the class as a unit of analysis. To compare the effect of the characteristics of four schools, a one-way ANOVA was performed for each scale.

No statistically significant differences were found among the four schools for Teacher Control. On the scale of Sense of Isolation, students in public school N felt less sense of isolation than others. The mean scale scores of School N and School T were significantly different. Students in the private school felt a stronger sense of isolation than students in public school N. With the scale of Order and Discipline, statistically significant differences were found between school T and all the other schools on Order and Discipline, suggesting that the CES-J is sensitive to the firm educational philosophy of this private school and reflects students' perceptions of order and discipline. With 'WA' Affiliation, the difference between School N and all of the other schools was statistically significant as it was for Sense of Isolation. As most students in School N participated in club or student council activities, they felt less isolated and there was a greater sense of cohesion among students.

The second part of this study in Japan involved the characteristics of juvenile delinquents and non-attendant students. The CES-J was administered to 266 public junior high school students (132 males and 134 females), 105 delinquent boys in correctional institutions, and 11 non-attendant students (8 males and 3 females). For both junior high school students and non-attendant students, there were no statistically significant gender differences for any factor; therefore, male and female data were combined.

The results were analysed using ANOVA with CES-J as the dependent variable and junior high school students/juvenile, delinquents/non-attendant students as the independent variable. Although no statistically significant group difference was found for Teacher Control, significant differences were seen for some items. Juvenile delinquents felt that teachers talked down to them more, that teachers led them less patiently, and that assignments were less reasonable than did junior high school students. Non-attendant students felt that assignments were unclear and that they did not know what to do in the classroom ($p<0.05$). The notable feature among delinquent boys on CES-J was their high score for Sense of Isolation; there was a statistically significant difference between boys in correctional institutions and students in public schools. Delinquent boys felt more loneliness at school than other ordinary students. With Order and Discipline, no statistically significant differences were found for this factor. But, non-attendant students thought that they daydreamed in class more than did other ordinary students in junior high school. A statistically significant difference was seen for 'WA' Affiliation between non-attendant students and the other two groups. Non-attendant students felt a greater maladjustment towards harmonising with peers than did delinquents and ordinary students. Non-attendant students had significantly greater difficulty in getting together with a group to do a project in class.

In Singapore, the growing pool of literature related to classroom learning environments across different subjects includes classroom studies of: computing (Khoo & Fraser, 1998; Teh & Fraser, 1994); geography (Chionh & Fraser, 1998); mathematics (Goh, Young & Fraser, 1995); and science (Wong & Fraser, 1996; Wong, Young & Fraser, 1997). Also a study from Brunei investigated how the introduction of new curricula has influenced learning environments in high school chemistry classes (Riah & Fraser, 1998). The questionnaires used in these studies were written in English and validated for use in Singapore or Brunei. The findings in each study replicate those of past research, reporting strong associations between the learning environment and student outcomes for almost all scales.

In Singapore, Chionh and Fraser (1998) cross-validated a version of the *What Is Happening In This Class?* (WIHIC) questionnaire with a group of geography and mathematics students. They also investigated the relationships between classroom environment and the learning outcomes of achievement, attitudes and self-esteem among these geography and mathematics students. A third purpose of their study was to investigate differences in students' perceptions of their geography and mathematics classroom environments. The study involved 2310 Secondary Four (Grade 10) students of the Express/Special Course in 75 randomly-selected classes from 38 randomly-selected schools in Singapore. For the investigations of associations between classroom environment and outcomes, a 24-item semantic differential attitude instrument and a 20-item self-esteem inventory were developed.

For all scales of the WIHIC questionnaire, with the exception of one (Autonomy/ Independence scale), the *a priori* seven-factor structure was replicated almost perfectly. Virtually all the 70 items had a factor loading of greater than or equal to 0.4 with their *a priori* scale and a loading of less than 0.4 with all other scales.

The comparison of geography and mathematics samples revealed that both groups of students had almost similar general perceptions of their learning environments. However, better examination scores were found in classrooms perceived as having more student cohesiveness, whilst attitudes and self-esteem were more favourable in classrooms perceived to have more teacher support, task orientation and equity.

Also in Singapore, Wong and Fraser (1996) investigated the associations between students' perceptions of their chemistry laboratory classroom environment and their attitudes towards chemistry, using a sample of 1592 final year secondary school chemistry students in 56 classes in 28 randomly-selected coeducational government schools. Students' perceptions of their Chemistry Laboratory environment were assessed using the *Chemistry Laboratory Learning Environment Inventory* (CLEI), which is a modified version of the *Science Laboratory Environment Inventory* (SLEI). The questionnaire on Chemistry-Related Attitudes (QOCRA), a modified form of the *Test of Science-Related Attitudes* (TOSRA), was used to assess the students' attitudes to chemistry.

Environment-attitude associations were explored using three methods of correlation analysis (simple, multiple and canonical) and two units of statistical analysis (the individual and the class mean). Significant associations were found between the nature of the chemistry laboratory classroom environment and the students' attitudinal outcomes.

In Hong Kong, qualitative methods involving open-ended questions were used to explore students' perceptions of the learning environment in Grade 9 classrooms (Wong, 1993, 1996). This study found that many students identified the teacher as the most crucial element in a positive classroom learning environment. These teachers were found to keep order and discipline whilst creating an atmosphere that was not boring or solemn. They also interacted with students in ways that could be considered friendly and showed concern for the students. Also, in Hong Kong, Cheung (1993) used multilevel analysis to investigate the effects of the learning environment on students' learning. The findings of this study provide insights that could help to explain why Hong Kong was found to rank highly in achievement in physics, chemistry and biology in international comparisons (Keeves, 1992).

2.10 CROSS-NATIONAL STUDIES OF CLASSROOM ENVIRONMENTS

International studies are becoming more and more popular in educational research (Wubbels, 1993). Studies bringing together data from different countries can be found in learning environment research. It is important to undertake cross-national studies of learning environments for the following reasons:

1. These kinds of studies avoid an Anglo-Saxon emphasis or bias in results from educational research. As a lot of results reported in the literature originated from the United States, the United Kingdom and Australia, the generality of these results to other cultures or countries can be questioned (Wubbels, 1993);

2. Cross-national studies broaden the perspective for the researchers and thus they could help to strengthen their sensitivity to idiosyncratic features of their own educational system. Without cross-national studies, researchers' interpretations of what is happening in classrooms could tend to focus on their own educational systems and therefore they might not see that slight variations between systems can make big differences in educational processes and the outcomes of these processes. Carrying out cross-national comparisons can help researchers to become aware of their implicit theories about teaching and learning (Stigler & Perry, 1988) by making the familiar unfamiliar. Thus, researchers can make more thoughtful conclusions based on their research results.

3. International comparisons can contribute to better understanding of the relative influence of a number of significant variables on the teaching and

learning processes (Robitaille, 1992). As Husén (1967) has said, international comparative studies use the world as an educational laboratory. The variability that is found in a study sample can be increased for many variables by involving more countries in the study, because of the natural variability across countries. Including two or more countries in studies of learning environments gives the opportunity to compare effects of different learning environments in a natural way instead of having to manipulate these environments through experimental conditions. In this section, a few recent cross-national/cultural studies of learning environments are reviewed.

The Classroom Environment Study of the International Association for the Evaluation of Educational Achievement (IEA) showed that learning environments in eight countries were extremely different on certain aspects (Anderson, Ryan, & Shapiro, 1989). Whereas in Nigeria, for example, the learning environment is characterised by nearly exclusively teacher-initiated activity and students listening and writing, in Australia, students and teachers initiate activities equally. Another interesting result from the Classroom Environment Study was the finding that, in some countries (Hungary, Republic of Korea, Thailand), almost all teachers were able to deal with student behaviour problems whereas, in many Western countries, teachers were less able to stop disorder or prevent it.

Fraser, Giddings, and McRobbie (1992) investigated the science laboratory classroom environments in a number of schools and universities in six countries (Australia, USA, Canada, England, Israel and Nigeria). The sample consisted of 3,727 students from 198 classes in schools and of 1,720 students from 71 university classes. One major purpose of their research was to develop, validate and use a new instrument, the *Science Laboratory Environment Inventory* (SLEI), which is specifically suited to science laboratory environments at either the upper secondary school or higher education level. Data from the six-country sample provided strong evidence that science laboratory classes around the world are dominated by closed-ended activities. It was also found that females held more favourable perceptions than males and that there were statistically significant associations between attitudinal outcomes and laboratory environment dimensions.

Aldridge and Fraser (2000) have recently completed a cross-national study of classroom environments in Taiwan and Australia. Their research is distinctive in that it not only provides an example of one of the few cross-national studies in science education, but it also used multiple methodologies from different paradigms in exploring the nature of classroom learning environments in Taiwan and Australia. Triangulation was used to secure an in-depth understanding of the learning environment and to provide richness to the whole. The idea of 'grain sizes' (the use of different-sized samples for different research questions varying in extensiveness and intensiveness) in learning environment research (Fraser, 1999) has been used effectively in studies that combine different methodologies (Fraser & Tobin, 1991; Tobin & Fraser, 1998), and was used to guide the collection of data for their study.

The *What Is Happening In This Class?* (WIHIC) questionnaire was used to measure students' perception of their classroom environment, and an eight-item scale based on a scale from the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981a) was used to assess students' satisfaction in terms of enjoyment, interest and how much they look forward to science classes. The instruments were translated into Chinese by researchers based in Taiwan. The Chinese versions were then back translated independently by Taiwanese researchers not involved in the original translation (Brislin, 1970). The Australian researchers checked the back translations and for some items, this necessitated the modification of the original English version, the Chinese version, or both.

The final 70-item version of the WIHIC questionnaire, along with the attitude survey, were administered to a sample of 1,081 Grades 8 and 9 general science students from 50 classes in 25 schools in Western Australia and 1,879 Grades 7-9 students from 50 classes in 25 schools in Taiwan. The data collected using the questionnaires were analysed to provide information regarding the reliability and validity of the questionnaires in each country, and to inform the researchers of the differences and similarities between student's perceptions in each country.

Principal components factor analysis followed by varimax rotation resulted in the acceptance of a revised version of the instrument composing 56 items with 8 items in each of the seven scales. The *a priori* factor structure of the final version of the questionnaire was replicated in both Australia and Taiwan, with nearly all items having a factor loading of a least 0.40 on their *a priori* scale and no other scale. The internal consistency reliability (Cronbach alpha coefficient) of each of the seven-item scales for two units of analysis (individual and class mean) was also reported. Using the class mean as the unit of analysis, scale reliability estimates ranged from 0.87 to 0.97 in Australia and from 0.90 to 0.96 in Taiwan. An analysis of variance (ANOVA) was used to determine the ability of each WIHIC scale to differentiate between the perceptions of students in different classes. The eta^2 statistic was calculated to provide an estimate of the strength of association between class membership and the dependent variable (WIHIC scale). Each scale differentiated significantly between classes ($p<0.01$) in both Taiwan and Australia. The amount of variance in scores accounted for by class membership (i.e. eta^2) ranged from 0.07 to 0.15 in Australia and from 0.07 to 0.36 in Taiwan.

The differences in mean environment and attitude scores for Taiwan and Australia were investigated (Aldridge & Fraser, 2000). Australian students consistently perceived their environments more favourably than did Taiwanese students. Effect sizes and *t* tests were calculated to investigate the differences between students' perceptions in Australia and Taiwan. The effect size for five of the seven scales of the WIHIC questionnaire ranged between approximately a quarter of a standard deviation and over three-quarters of a standard deviation for class means. These effect sizes suggested a substantial difference between countries on the learning environment scales with the exception of Student Cohesiveness and Teacher Support. Using the class as the unit of analysis, *t*-tests for paired samples were used to investigate whether differences in scale scores between Australia and Taiwan were statistically significant. Students in Australia consistently viewed their classroom environment (in terms of WIHIC scales) more favourably than did students in Taiwan. There was a statistically significant difference ($p<0.05$) for the scales of: Involvement; Investigation; Task Orientation; Cooperation; and Equity.

Students in Taiwan, however, expressed a significantly more positive attitude towards science than did students in Australia ($p<0.01$). The effect size for students' attitudes was over two thirds of a standard deviations for class means, also suggesting large differences between the two countries. Despite Australian students holding more favourable perceptions of the learning environment, it appeared that students in Taiwan had more positive attitudes towards their science class.

Prompted by the above findings, the researchers examined the perceptions in each country using classroom observations, interviews with teachers and students, and narrative stories written by the researchers (Aldridge, Fraser & Huang, 1999; Aldridge & Fraser, 2000). After gathering the qualitative data, three important points emerged for the researchers. Firstly, whilst the classroom environments are different in the two countries, the questionnaire scores do not necessarily reflect fully the overall quality of education. Secondly, when interpreting the data for scales of the WIHIC questionnaire, consideration needed to be given to whether the scales reflect what is considered to be educationally important in the countries and cultures from which the data were collected. Finally, Aldridge and Fraser (2000) found that comparisons of quantitative data from different countries should be made with caution because there were some items for which students in one country interpreted slightly differently from students in another country (as with the Student Cohesiveness scale).

Margianti, Fraser and Aldridge (2002) studied the influence of the classroom learning environment on students' cognitive and affective outcomes. The sample involved 1,056 third-year computer students in 33 classes in one private university in Indonesia. Students' perceptions of the classroom environment were measured using a modified Indonesian version of the *What Is Happening In This Class?* (WIHIC) questionnaire. To assess students' affective outcomes, the Enjoyment of Science Lessons scale derived from the *Test of Science-Related Attitudes* (Fraser, 1981a) was adopted for use in higher education classes and translated into Indonesian. A secondary aim of their research was to compare males' and females' perceptions of actual classroom environments. The data collected using the questionnaires were used to determine their validity and reliability. Statistical analyses included Cronbach's alpha reliability coefficient to determine internal consistency reliability, and factor analysis to check the factor structure of the learning environment questionnaire. Differences between students' perceptions of actual and preferred learning environment were analysed using *t* tests for paired samples, and differences between the perceptions of male and female students were analysed using t tests for independent samples. To determine whether associations exist between the learning environment and students' academic and affective outcomes, simple correlation analysis and multiple regression analysis were used.

2.11 CHAPTER SUMMARY

In line with the present study's questions, this chapter reviewed literature in several areas: definition of key terms and concepts; research approaches for investigating classroom environments; unit of statistical analysis; pioneering research on classroom environment; learning environment instruments; attitude-measuring techniques and instruments; and review of past research on learning environments.

As a major thrust of the present study was to investigate relationships between classroom environments and attitudes, literature related to attitudes was also reviewed. Because this study was cross-national and involved Australia and Indonesia both earlier and recent studies of classroom environment in the Southeast Asian region were considered. Literature on the few recent cross-national studies of classroom environment was also reviewed in this chapter.

As gender differences in students' perceptions of classroom environment and in students' attitudes to science were also a part of the three research questions, relevant gender studies were also reviewed in Chapter 2.

Chapter 3

RESEARCH METHODS

3.1 INTRODUCTION

This chapter describes and justifies different aspects of the present study in terms of the following headings:

- Research design (Section 3.2);
- Sample of schools and students (Section 3.3);
- Instrumentation (Section 3.4);
- Data Collection (Section 3.5);
- Data Entry (Section 3.6) ;
- Data Analysis (Section 3.7); and
- Conclusion (Section 3.8)

3.2 RESEARCH DESIGN

The present study was primarily a quantitative one using the questionnaire survey method. Students' perceptual measures of the classroom environment were employed in the questionnaire study because there is much merit in engaging the students to report as milieu inhabitants. Fraser and Walberg (1981) have discussed these merits at length. The advantages include: economy in terms of time and finance, as this method dispenses with the employment and training of outside observers; more accurate representations could be obtained as "perceptual measures are based on students' experiences over many lessons..." (Fraser, 1994, p. 494) when compared to a small number of lesson observations by an outside observer; collective representation of the members of the class is reflected as opposed to that from usually a single outside observer; students' behaviours are influenced more by their perceptions than by the situation as observed by an outsider; and research has shown that students' perceptual measures of classroom environments contribute more to the variance in student learning outcomes than do directly-observed variables.

As mentioned in Chapter 1, the focus of the present study was on the psychosocial classroom environments in two countries, namely, Australia and Indonesia. The subsections below elaborate the general procedures for the present study, the choice of Australia and Indonesia for this cross-national study, and the choice of schools and grade level for the study.

3.2.1 General Procedures for the Study

The first phase of the present study included: the selection of the classroom environment as the focus; a review of relevant literature; the identification of the research questions; the choice of countries for the cross-national study; the selection of suitable measuring instruments for the study; the choice of schools for the sample;

and the choice of grade level of the student sample. Two instruments were chosen for this study: (1) the *What Is Happening In This Class?* (WIHIC) questionnaire was chosen to measure students' perceptions of their classroom environment; and (2) the *Test of Science-Related Attitude* (TOSRA) was chosen to measure students' attitude to science.

The study involved the choice of two countries for the cross- national study. Australia and Indonesia were chosen because they are two neighbouring countries with distinctly different historical, cultural and religious characteristics. Then came the choice of schools for the sampling. Private and coeducational schools in both countries were chosen as they represented middle to upper socio-economic brackets. Finally, the student sample comprised of Year 9/10 students in Australia and students of an equivalent grade level in Indonesia. Following this, permission was obtained from Directors of Education in Sydney, New South Wales and Perth, Western Australia to administer the two questionnaires in their private coeducational secondary schools. Subsequently, permission from the respective schools' principals was requested for the administration of the questionnaire survey to their schools' Year 9/10 students. The required sets of questionnaires were also printed during this stage.

The third phase involved the translation of both questionnaires, that is, the WIHIC and TOSRA, into Bahasa Indonesia. Postgraduate Indonesian students studying in Sydney and Perth at the time of this study did this. The Indonesian versions of these questionnaires were then back-translated (Brislin, 1970) by an Indonesian teacher of

English with many years of experience in teaching English in Indonesia and Australia. The back-translated English versions of these questionnaires had some errors, which had to be rectified in the Indonesian versions. The Indonesian versions of the questionnaires were then printed, ready to be administered in Indonesia. Because of the fact that principals of most schools in Indonesia do not speak and understand English, the researcher had to rely on the Indonesian English teacher and the Indonesian postgraduate student, who had been responsible for the translation of the questionnaires, to seek the required permission from the authorities and school principals before organising the administration of these questionnaires to a minimum of four schools and a minimum of 700 Year 9/10 Indonesian students.

After the administration of the questionnaires in both Australia and Indonesia, the fourth phase consisted of the data entry process. For the present study, the data were keyed into spreadsheets using Microsoft Excel 95. Further discussion of the administration of the questionnaire survey and the data collection is given in Section 3.6. The data were then processed and analysed statistically using techniques outlined in section 3.7.

3.2.2 Choice of Countries for the Study

Australia and Indonesia were the two countries selected for this cross-national study because they are two geographically big countries with very different historical, cultural and religious characteristics. Australia is a country with an area of 7,652,300 square kilometres but with a population of less than 20 million people spread among six states. Indonesia is an archipelago made up of 17,000 islands (6,000 inhabited) with a total area of 1,919,440 square kilometres. The Indonesian population, however, is just over 200 million people. The main spoken language in Australia is English while Indonesians speak Bahasa Indonesia. The Australian culture is predominantly Anglo-Saxon and Christianity is the main religion. Indonesia is the biggest Muslim community in the world. In Australia, the six states run their own educational system while, in Indonesia, the education system is run from Jakarta, the capital of its main island, Java.

3.2.3 Choice of Schools and Grade Level for Study

As the chosen size of the Australian Sample was around 600 students and the chosen size of the Indonesian Sample was 700, the researcher decided to sample 4 private coeducational schools in two cities of Australia (2 schools in Sydney, New South Wales and 2 schools in Perth, Western Australia) and to sample 4 private coeducational schools in two cities of Indonesia (2 schools in Jakarta, Java and 2 schools in Singaraja, Bali). The reason why the Australian sample was smaller than the Indonesian sample is because the average Australian class has 25 students while the average Indonesian class has 35 students. So it was anticipated that a total of around 36 classes (18 classes in Australia and 18 classes in Indonesia) would form the sample in each of the two countries.

For students to report their perceptions of their classroom environments and their attitudes to science, the researcher chose students who had completed a minimum of two years of high school. This was to ensure that students sampled would have an adequate understanding of the items in the questionnaires and would have had enough classroom and laboratory experiences in science to have developed and formed an attitude towards this subject.

3.3 SAMPLE OF SCHOOLS AND STUDENTS

This section describes the characteristics of the schools and the students sampled in the two countries, Australia and Indonesia.

3.3.1 Sample of Schools

In both Australia and Indonesia, schools are categorised as: (1) state schools (government schools); (2) private single-sex schools; and (3) private coeducational schools. Private schools are either denominational or non-denominational. In Australia, the school system starts at the pre-school level, for children usually below the age of 5 years, then the kindergarten level for students around the age of 5 years and the primary level for students between the ages of 5 to 11 years. On completion of the primary school programme, students move to a high school that is made up of a junior secondary section (Years 7–10) and a senior secondary section (Years 11 and 12). In Indonesia, the school system starts at the pre-school level, for children usually below the age of 4 years, then the kindergarten level for students around the age of 4 years, and the primary level for students between the ages of 6 to 12 years. On completion of the primary school programme, students move to a high school which is made up of a junior secondary section (years 7–9) and a senior secondary section (years 10–12).

As it would have been practically impossible to sample every type of school in either Australia or Indonesia, the researcher decided to choose only private coeducational schools in two cities in each of the two countries. One of the reasons for choosing schools from the private sector was that it provided the researcher with students of middle to upper socioeconomic backgrounds.

3.3.2 Sample of Students

The sample for the present study consisted of a total of 1,161 students in 36 Year 9/10 classes in 8 randomly-selected private coeducational schools in Australia (4 schools in 2 cities) and in Indonesia (4 schools in 2 cities). Table 3.1 shows the distribution of the sampled schools and classes in the two countries, Australia and Indonesia.

Table 3.1 Sample Size in Australia and Indonesia

Country	City	Number of Schools	Number of Classes	Number of Students
Australia	Sydney, NSW	4	9	278
	Perth, WA	4	9	289
Indonesia	Jakarta, Java	4	9	291
	Singaraja, Bali	4	9	303
Total		16	36	1,161

Students in both Australia and Indonesia were either 14 or 15 years of age and had both completed a minimum of two years of lower secondary education. Being 14 and 15 year-old students, they would also be able to understand the meaning of the items in the questionnaires and hopefully make logical decisions when completing the questionnaires. At that age, relationships between student and student and between student and teacher are more meaningful and these students start to perceive their classroom environments more like young adults than like children.

3.4 INSTRUMENTATION

Two instruments were used to gather data for this study: the *What Is Happening In This Class?* (WIHIC) questionnaire was used to measure students' perceptions of their classroom environment; and the *Test of Science-Related Attitudes* (TOSRA) was used to assess students' attitudes towards their science classes.

3.4.1 What Is Happening in This Class? (WIHIC) Questionnaire

The *What Is Happening in This Class?* (WIHIC) questionnaire was used to measure students' perceptions of their classroom environment. This instrument was developed by Fraser, McRobbie and Fisher (1996) to bring parsimony to the field of learning environments by combining the most salient scales from existing questionnaires with new dimensions of contemporary relevance to science education.

There were nine scales of 10 items each in the first version of the WIHIC questionnaire. Arising from field-testing of this version in Australia, the second version containing the following eight scales with 10 items each was developed:

Student Cohesiveness (SC)	Extent to which students know, help and are supportive of one another;
Teacher Support (TS)	Extent to which the teacher helps, befriends, trusts and is interested in students;
Involvement (IN)	Extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class;
Autonomy/Independence (AI)	Extent to which students have to make their own decisions and choose their own modes of learning;
Investigation (IV)	Emphasis on the skills and processes of inquiry and their use in problem solving and investigation;
Task Orientation (TO)	Extent to which it is important to complete activities planned and to stay on the subject matter;
Co-operation (CO)	Extent to which students cooperate rather than compete with one another on learning tasks; and
Equity (E)	Extent to which students are treated equally by the teacher.

Fraser, McRobbie, and Fisher (1996) conducted principal components factor analysis on data collected from administration of the original 80-item version. This analysis followed by varimax rotation resulted in the acceptance of a revised version of the instrument comprising a smaller number of items. New items were developed and added to form a second version of the WIHIC containing 80 items.

It is the second 80-item version of the WIHIC questionnaire which was chosen for the present study. The three main reasons for the choice of the WIHIC questionnaire are:

1. Of the existing classroom environment instruments, the WIHIC questionnaire stands out as being parsimonious (Fraser, McRobbie & Fisher, 1996). The WIHIC questionnaire can provide a fairly comprehensive and clear indication of the 'actual' state of the psychosocial learning environment of the classroom, as well as the 'preferred' state of the educational environment as desired by the learners. As such, it captures the essence of the general 'health' of the classroom.

2. The items in the instrument are generally 'non-threatening' to the 'players', namely, the teacher and the students in the classroom. Teachers and students do not feel intimidated, as the items do not directly assess performance, personality or character. It is human nature that people will not want to subject themselves to direct scrutiny and assessment. Therefore, the WIHIC questionnaire is likely to receive endorsement from the general population of teachers and students in

Indonesia. Of the eight scales in the second version, potentially most sensitive scale is Teacher Support, which involves the extent to which the teacher provides assistance to the students in the classroom.

3. With respect to the above two reasons, the WIHIC questionnaire is an efficacious and economical instrument for teachers who are keen on improving their classroom environments or getting feedback or assurance about their invested effort when they administer the instrument to their own classes. Therefore, use of the WIHIC questionnaire in the present study would pave the way for Indonesian teachers and researchers to use this questionnaire in the future. Furthermore, in order for the teachers and researchers in Indonesia to be able to use the instrument with confidence, cross-validation of the WIHIC questionnaire with a large sample in Indonesian schools was a necessary part of the present study.

Actual Version versus Preferred Version

The actual version of the WIHIC questionnaire measures students' perceptions of practices which happen in the classroom learning environment (psychosocial state) as experienced by them. In contrast, the preferred version of the WIHIC questionnaire is concerned with "goals and value orientations" (Fraser, 1994, p. 499) and it measures the students' perceptions of the 'ideal' state of the classroom learning environment in which they would like it to be. For the purpose of the present study, the actual version of the WIHIC questionnaire was used.

Class Form versus Personal Form

There are two forms of the WIHIC questionnaire, namely, a Class Form and a Personal Form. The Class Form "applies to the class as a whole", whereas the Personal Form focuses on "the student's own role within that classroom environment" (Fraser, Giddings & McRobbie, 1995, p. 409). The present study used the Class Form for the following reasons:

1. The Class Form provides a conventional way whereby students in a class are invited to be the 'eyes' for the researchers and to report on the general 'health' of the psychosocial classroom environment as a whole.

2. With regard to the discussion in Section 3.4.1 about the 'non-threatening' nature of the items in the questionnaire, the Class Form is suitable as the students are not required to respond to items which would elicit their "own role within the classroom", as it would have been in the case of the Personal Form (Fraser, Giddings & McRobbie, 1995, p. 409; see also Fraser, McRobbie & Fisher, 1996). This further explains why the Class Form has been chosen instead of the Personal Form as the later, being 'personal', might cause unnecessary anxiety for students who might be sensitive and might not wish to reveal matters concerning themselves (and at the same time would like to be helpful by participating in the survey). Generally, people are more willing to volunteer their perceptions of generalised conditions rather than to be specific about what they themselves feel or experience. This is all the more so if they

are responding in a questionnaire survey to the researcher who is a 'stranger' to them.

3. The Personal Form is particularly relevant in small-scale case studies of individual students (Fraser, Giddings & McRobbie, 1995). Because this purpose was not relevant to the main aims of the present large-scale study (which involved using the class mean to establish broad relationships), and in order to get more representative participation of students for the study, the Class Form was chosen.

3.4.2 Test of Science-Related Attitudes (TOSRA)

To assess students' attitudes towards science, the *Test of Science-Related Attitudes* (TOSRA) was used. Fraser (1978) developed the TOSRA to measure seven distinct science-related attitudes among secondary school students. These seven attitude scales are: Social Implications of Science; Normality of Scientists; Attitude to Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science. Each scale contains 10 items, making a total of 70 items for the whole instrument. The response scale is a five-point Likert scale and has response categories ranging from Strongly Agree to Strongly Disagree. A description of the seven scales, a classification of each scale according to Klopfer's (1971) scheme, and a sample item for each scale is given in Table 2.2, Chapter 2.

The TOSRA is actually an extension and improvement of a previous set of five attitude scales which contained earlier versions of the following five scales: Social Implications of Science; Attitude to Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; and Leisure Interest in Science (Fraser, 1981a). This battery of five attitude scales was field tested with samples from Year 7 students and refined. Then it was extended and improved in the following four ways to evolve a preliminary version of the TOSRA:

1. Two new scales, Normality of Scientists and Career Interest in Science, were added.

2. The three different sets of administration instructions and answering formats of the previous battery were condensed into a single set of instructions and answering format for the TOSRA.

3. Each TOSRA scale contained the same number of items instead of having different number of items in each scale, as was the case in the original battery of scales.

4. The TOSRA was field tested and validated with student samples from all four junior high school grade levels (Years 7–10) rather than just Year 7 alone.

Next, the preliminary version of the TOSRA was commented upon by a group of science teachers and experts in educational measurement. Based on their feedback, the TOSRA was refined further. This interim version, containing 14 items per scale, was field tested with a sample of 1,337 Year 7–10 students in 44 classes from 11 schools in Australia. Following a series of statistical analyses that were performed on the data obtained, a final version of the TOSRA comprising 10 items per scale was evolved. The scales of this refined version were found to display satisfactory internal consistency reliability, test-retest reliability and discriminant validity (Fraser, 1981a).

Since its development, the TOSRA has been further cross-validated with several new samples of secondary science classes from Australia and the USA:

- 567 Year 10 students from four high schools in Brisbane, Australia (Lucas & Tulip, 1980);
- 273 Year 12 students from four high schools in Brisbane, Australia (Lucas & Tulip, 1980);
- 1,041 Year 8-10 students from 11 schools in Perth, Australia (Schibeci & McGaw, 1980);
- 712 Year 7-9 students from eight schools in Sydney, Australia (Fraser & Butts, 1982);
- 546 Year 9 girls in 2 schools in Philadelphia, USA (Fraser & Butts, 1982); and

- 1,594 upper secondary school students from 52 schools in Queensland, Australia (McRobbie & Fraser, 1993).

On the whole, it was found that all cross-validation data compared favourably with the original validation data.

Furthermore, teachers and researchers have found the TOSRA to be a useful and easy-to-use instrument for measuring and monitoring progress of science-related attitudes of individual students or whole classes of students. For example, it can be used in a pretest-posttest situation to find out if students have changed their science-related attitudes over a period of time, such as a school year. Besides this, the TOSRA also makes it possible for researchers and teachers to obtain a 'profile' of attitude scores for a particular group of students. This is a major advantage that the TOSRA has over other science attitude tests which yield only a single overall score rather than a separate score for a number of distinct attitudinal measures.

3.4.3 Translation and Back-Translation of the Questionnaires

As the two questionnaires had to be administered in the two countries, namely, Australia and Indonesia, the questionnaires had to be translated into Bahasa Indonesia as the students in Indonesia could not have completed the questionnaires if they were in English. Section 3.2.1 describes how the English versions of the WIHIC questionnaire and the TOSRA were translated into Bahasa Indonesia by an Indonesian doctoral student at Curtin University of Technology and then back-translated into English by an Indonesian who has been teaching English for many years at the senior high school level in Jakarta. The back translations, recommended by Brislin (1970), were checked by a third party, an experienced senior teacher of Bahasa Indonesia and fluent in English. Attempts were made to ensure that the Indonesian versions of the two questionnaires (WIHIC and TOSRA) maintained the original meanings and concepts in the original English version.

3.5 DATA COLLECTION

3.5.1 Data Collection in Australia

When the questionnaires were ready for administration, the researcher contacted the principals of a few schools in Sydney, New South Wales, and Perth, Western Australia, for permission to administer these two questionnaires to four of their Year 10 and/or Year 9 classes. When permission was granted, the researcher sent the required number of questionnaires and asked the teachers responsible for the actual administration of the questionnaires to ensure that classes were kept separate.

3.5.2 Data Collection in Indonesia

In Indonesia, the researcher had to request permission for administration of the questionnaires with the help of two teachers, who were known to the researcher. In

Australia and Indonesia, the required number of questionnaires was sent to the schools as soon as permission was granted. The questionnaires were collected on completion. Classes were, once again, kept separate.

Students in both Australia and Indonesia ticked a box to indicate their country of origin, gender, age and grade level. Names of schools, names of teachers and names of students did not appear on any part of the questionnaires.

On receipt of the questionnaires, the researcher labelled the location of the school (e.g. School A: Stratfield, NSW, Australia or School B: Singaraja, Bali, Indonesia).

3.6 DATA ENTRY

After the data collection was completed, the data were entered into Microsoft Excel 2000 for further analysis using SPSS version 10. Three major steps were taken during data entry:

1. The format for data entry was set up. This format captured three main types of information, namely, general students' background, students' responses to the WIHIC, and students' responses to the TOSRA. The student's background section provides room for student's ID, age, gender, grade and country. The WIHIC and TOSRA sections have 80 and 70 columns, respectively (i.e. one for each item).

2. The second step involved coding all students' responses to both questionnaires. The coding was aimed at differentiating students into their class, gender and country. The coding was arbitrary and only for analysis purposes.

3. The last step was to put all data together into the data format. Indonesian students' responses were entered first, and then those of Australian students. Finally, this spreadsheet that contains all data was relocated to SPSS version 10 for analysis purposes.

3.7 DATA ANALYSIS

The SPSS (version 10.0) statistical package was used to analyse students' responses to furnish evidence for the WIHIC and TOSRA regarding factor structure, scale internal consistency reliability, and ability to differentiate between the perceptions of the learning environment among students in different classrooms. A principal components factor analysis with varimax rotation was used to determine whether all of the items from the eight WIHIC scales in the original questionnaire (Student Cohesiveness; Teacher Support; Autonomy/Independence; Involvement; Investigation; Task Orientation; Co-operation; and Equity) formed eight independent measures of the psychosocial learning environment. A principal components factor analysis with varimax rotation was also used to determine whether all of the items from the seven TOSRA scales in the original questionnaire (Social Implication of Science; Normally of Scientists; Attitude to Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science) formed seven independent measures of the attitude to science.

Cronbach's alpha reliability coefficient was calculated as an index of internal consistency reliability of the WIHIC and TOSRA. The discriminant validity of each scale was determined by calculating the mean correlation of each scale with other scales. All of these analyses were performed at both the individual student and the class levels. An ANOVA was also used to determine the ability of each WIHIC scale to differentiate between the perceptions of student in different classes (unit of analysis).

A two-way MANOVA with repeated measures on one factor was used to explore differences between countries (Indonesia and Australia) and genders in terms of students' perceptions of classroom environment and attitudes to science. The within-class gender subgroup mean was used as the unit of analysis.

To determine whether associations exist between student perceptions of the learning environment and student attitudes to science, simple correlation and multiple regression analyses were conducted at two levels of analysis (the student and the class).

3.8 CONCLUSION

The research design of the present study was a quantitative one using the questionnaire survey method. Two instruments were used to collect the data for this study. First, the second version of the *What Is Happening In This Class?* (WIHIC) questionnaire was used to assess students' perceptions of their classroom learning environment and, second, the *Test of Science-Related Attitude* (TOSRA) was used to explore students' attitudes to science. The choice of these two instruments was discussed in this chapter.

In addition to the justification of the choice of instruments, the reasons for the choice of the countries and grade level for this cross-national study were provided. The nature of the school and student sample (namely, 1,161 students in 36 classes in 16 schools in two countries) was also described in this chapter. As the two questionnaires used were translated into Indonesian and then back-translated, this careful process was also described in some detail. The chapter also described the choice of the units of statistical analysis, as well the statistical analysis procedures employed to answer the research questions.

For the cross-validation of the WIHIC and TOSRA, factor and item analyses were chosen. Cronbach's alpha reliability and ANOVA for class membership differences were used to provide further evidence of scale validity and reliability. A two-way MANOVA was used in exploring differences between countries (Indonesia and

Australia) and genders in terms of students' perceptions of classroom environment and their attitudes to science. For the investigation of the associations between classroom environment and attitudes, two statistical methods of analyses were chosen: simple correlation analysis and the multiple regression analysis. Chapter 4 reports the findings of these statistical analyses.

Chapter 4

DATA ANALYSES AND FINDINGS

4.1 INTRODUCTION

This chapter is devoted to describing the data analyses and findings for the quantitative survey data from this study. A main purpose of the study was to validate English and Indonesian versions of the *What Is Happening In This Class?* (WIHIC) questionnaire and the *Test of Science-Related Attitudes* (TOSRA) for use in Australia and Indonesia. The WIHIC questionnaire measures students' perceptions of their classroom environment and the TOSRA assesses students' attitudes to science. A second purpose of the study was to find out whether students' perceptions of their learning environment and students' attitudes to science vary with (a) country (Australia and Indonesia) and (b) student gender. The third and final purpose was to assess the strength of the associations between students' perceptions of their classroom environment and their attitudes to science in the two countries chosen for this research project, namely, Australia and Indonesia.

Analyses of the data collected using these instruments helped to answer the following research questions (discussed in this chapter):

Research Question #1

Is it possible to validate English and Indonesian versions of the WIHIC (What Is Happening In This Class*?) questionnaire and* TOSRA (Test of Science-Related Attitude) *for use in Australia and Indonesia?*

Research Question #2

Do students' scores on the WIHIC (What Is Happening In This Class*?) questionnaire and the TOSRA* (Test Of Science-Related Attitudes*) vary with:*

(a) country (Australia and Indonesia);

(b) *gender?*

Research Question #3

What is the strength of the associations between students' perceptions of their classroom environment and their attitudes to science in Australia and Indonesia?

The findings of the survey are reported in this chapter using the following headings:

- The validity and reliability of the WIHIC (What Is Happening in This Class?) and TOSRA (Test of Science-Related Attitude) (Section 4.2);

- Differences between countries and genders in learning environment and attitudes to science (Section 4.3); and
- Associations between students' perceptions of the learning environment and students' attitudes to science in Australia and Indonesia (Section 4.4).

4.2 VALIDITY AND RELIABILITY OF THE WIHIC AND TOSRA

This section discusses the following:

- Factor structure of WIHIC (4.2.1);
- Factor structure of TOSRA (4.2.2);
- Internal consistency reliability and discriminant validity of WIHIC (4.2.3);
- Internal consistency reliability and discriminant validity of TOSRA (4.2.4); and
- Ability of WIHIC to differentiate between classrooms (4.2.5).

4.2.1 Factor Structure of WIHIC

Statistical analyses were conducted to examine the internal structure of the 80 items of the version of the WIHIC questionnaire used in the present study. Principal components factor analysis with varimax rotation was used to generate orthogonal factors for each of the two data sets (Indonesia and Australia). This resulted in the elimination of two entire scales, namely, the Autonomy/Independence scale and the Cooperation scale. The factor analysis finally resulted in the acceptance of a revised version of the instrument comprising 55 items in 6 scales (see Table 4.1). After omission of two scales, the a *priori* factor structure of the final version of the questionnaire was replicated in both countries, with nearly all items having a factor loading of at least 0.30 on its own scale and on no other scale (reported in Table 4.1). The conventionally-accepted minimum value of 0.30 for factor loading to be meaningful was used.

Table 4.1 shows the factor loadings for the WIHIC questionnaire (six scales) for Indonesia and Australia, using the individual student as the unit of analysis, along with the percentage of variance and eigenvalue for each scale. The percentage variance varies from 5.73 % to 9.49 % for Indonesian students and from 5.50 % to 8.88 % for Australian students. The total proportion of variance explained is 46.25% for the Indonesian sample and 40.69% for the Australian sample. The value of the eigenvalue for different scales varies from 1.75 to 14.44 for Indonesian students and from 1.88 to 10.44 for Australian students.

Ideally, for each of the 55 items in Table 4.1, the factor loading should be at least 0.30 for its *a priori* scale and less than 0.30 for every other scale. This pattern clearly is evident for nearly all of the 660 loadings in Table 4.1 (55 items x 6 scales x 2 countries), with an exception occurring for a total of only 8 cases.

Table 4.1 Factor Loadings for the Modified WIHIC Items in Indonesia and Australia

Item No	Factor Loading											
	Student Cohesiveness		Teacher Support		Involvement		Investigation		Task Orientation		Equity	
	Indon	Aust	Indon	Aust	Indon	Aust	Indon	Aust	Indon	Aust	Indon	Aust
1	0.62	0.51										
2	0.45	0.48										
3	0.51	0.55										
4	0.64	0.39										
5	0.51	0.51										
6	0.61	0.70										
7	0.64	0.67										
8	0.48	0.52										
9	0.49	0.49										
10	0.64	0.46										
12			0.46	0.54								
13			0.73	0.62								
14			0.68	0.64								
15			0.61	0.52							0.33	
16			0.70	0.57								
17			0.73	0.64								
18			0.65	0.50								
19			0.39	•								
21					0.71	0.59						
22					0.75	0.68						
24					0.64	0.54						
26				0.31	0.51	0.37						
27		0.32			0.53	0.68						
28	0.39				0.38	0.50						
29					0.44	0.53						
30					0.52	0.49						
41							0.48	0.48				
42							0.65	0.69				
43							0.62	0.55				
44							0.69	0.73				
45							0.60	0.57				
46							0.69	0.74				
47							0.56	0.76				
48							0.42	0.50				
49							0.62	0.78				
50							0.57	0.72				
51									0.46	0.53		
52									0.49	0.43		
53									0.44	0.46	0.32	0.33
54									0.56	0.50		
55									0.54	•		
56									0.63	0.53		
57									0.69	0.58		
58									0.58	0.58		
59									0.61	0.65		
60									0.64	0.60		
71											0.69	0.68
72											0.66	0.58
73											0.70	0.75
74											0.68	0.58
75											0.67	0.73
76											0.75	0.66
77											0.72	0.67
79											0.53	0.36
80											0.63	0.64
% Variance	7.27	6.31	7.38	5.50	5.92	5.73	8.43	8.88	7.76	6.33	9.49	7.94
Eigenvalue	2.22	2.47	2.82	1.88	1.75	1.95	3.98	10.44	3.29	4.21	14.44	4.83

Factor loadings smaller than 0.30 have been omitted.

The sample consisted of 594 students in Indonesia and 567 students in Australia.

The only two cases for which an item's factor loading with its a priori scale is less than 0.30 are items 19 and 56, both for Australian sample. Also, there are six cases for which an item has a factor loading of greater than 0.30 on a scale other than its own scale: Item 15 loads on Equity as well as in its own scale (Teacher Support) for the Indonesian sample; Item 26 loads on Teacher Support for the Australian sample; Item 27 loads on Student Cohesiveness for the Australian sample; Item 28 loads on Student Cohesiveness for the Indonesian sample; and Item 53 loads on Equity for both the Indonesian and Australian students.

Overall Table 4.1 provides strong support for the factorial validity of both the English-language version of the WIHIC when used in Australia and the Indonesian-language version of the WIHIC when used in Indonesia. Therefore, the present study replicates research which has supported the factor structure of the WIHIC in Australia and Taiwan (Aldridge, Fraser, & Huang, 1999), Singapore (Chionh & Fraser, 1998), Brunei (Riah & Fraser, 1998), Canada (Raaflaub & Fraser, 2002; Zandvliet & Fraser, 1999), Korea (Lee & Fraser, 2001) and Indonesia (Margianti, Fraser & Aldridge, 2002) and the USA (Allen & Fraser, 2002).

4.2.2 Factor Structure of TOSRA

Principal component factor analysis with varimax rotation was used to generate orthogonal factors for each of the two data sets (Indonesia and Australia). Principal component factor analysis with varimax rotation resulted in the acceptance of a revised version of the instrument comprising of 20 items in three scales (see Table 4.2). Three of the TOSRA's original scales were retained: Normality of Scientists; Attitude to Scientific Inquiry; and Career Interest in Science. For this 20-item version of the questionnaire, nearly all items have a factor loading of at least 0.30 with their own scale and a loading of less than 0.30 with the other two scales (see Table 4.2). The only exceptions are Items 1 and 3 for the Australian sample.

Table 4.2 Factor Loadings for the Modified TOSRA in Indonesia and Australia

Item No	Factor Loading					
	Normality of Scientists		Attitude to Scientific Inquiry		Career Interest in Science	
	Indonesia	Australia	Indonesia	Australia	Indonesia	Australia
1	0.45	-				
2	0.40	0.50				
3	0.47	-				
4	0.57	0.58				
5	0.59	0.38				
6	0.46	0.54				
7			0.55	0.48		
8			0.54	0.51		
9			0.57	0.48		
10			0.54	0.41		
11			0.60	0.61		
12			0.50	0.51		
13			0.45	0.53		
14					0.65	0.51
15					0.46	0.56
16					0.55	0.54
17					0.60	0.42
18						
19						
20						
% Variance	8.44	7.58	10.66	9.61	11.75	11.09
Eigenvalue	1.90	1.84	2.46	2.09	3.85	3.80

Factor loadings smaller than 0.30 have been omitted.
The sample consisted of 594 students in Indonesia and 567 students in Australia.

As well as showing the factor loadings for TOSRA items for Indonesia and Australia, using the individual student as the unit analysis, Table 4.2 also shows the percentage of variance and eigenvalue for each scale. The percentage variance for the different scales ranges from 8.44 % to 11.75 % for Indonesian students and from 7.58 % to 11.09 % for Australian students. The total amount of variance explained by all factors is 30.85% for Indonesia and 28.28% for Australia. The eigenvalue for different scales ranges from 1.90 to 3.85 for Indonesian students and from 1.84 to 3.80 for Australia students.

For Indonesian students, every item in the 20-item version has a factor loading of at least 0.30 on its own scale and on no other scales. However, for the Australian sample, Item 1 and Item 3 have a loading of less than 0.30 on their own scale. But, apart from Items 1 and 3, all items have a factor loading of at least 0.30 on their own scale and less than 0.30 for the other two scales for the Australian sample.

4.2.3 Internal Consistency Reliability and Discriminant Validity of WIHIC

For the revised 55-item version of the WIHIC, two indices of scale reliability and validity were generated. The Cronbach alpha reliability coefficient was used as an index of scale internal consistency, and the mean correlation of a scale with the other two scales was used as a convenient index of discriminant validity. These analyses were performed at two units of analysis, namely, the individual student and the class mean.

Table 4.3 shows that the Cronbach alpha reliability coefficients for the six scales, using the individual student as the unit of analysis, are high and range from 0.82 to 0.92 for Indonesian students and from 0.78 to 0.89 for Australian students. With the class mean as the unit of analysis, the alpha reliability coefficients are generally higher, ranging from 0.75 to 0.95 for Indonesian students and from 0.88 to 0.97 for Australian students.

Table 4.3 Internal Consistency Reliability (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation With Other Scales) and Ability to Differentiate Between Classrooms (ANOVA Results) for Two Units of Analysis for the What Is Happening in This Class? (WIHIC) Questionnaire

Scale	Unit of Analysis	Alpha Reliability		Mean Correlation with other Scales		ANOVA Eta^2	
		Indonesia	Australia	Indonesia	Australia	Indonesia	Australia
Student Cohesiveness	Individual	0.82	0.81	0.32	0.23	0.07**	0.11**
	Class Mean	0.88	0.88	0.30	0.46		
Teacher Support	Individual	0.88	0.82	0.44	0.36	0.10**	0.08**
	Class Mean	0.91	0.92	0.56	0.56		
Involvement	Individual	0.85	0.78	0.40	0.32	0.05*	0.05*
	Class Mean	0.75	0.88	0.32	0.57		
Investigation	Individual	0.87	0.89	0.42	0.24	0.14**	0.12**
	Class Mean	0.95	0.94	0.61	0.70		
Task Orientation	Individual	0.87	0.78	0.43	0.31	0.11**	0.08**
	Class Mean	0.83	0.95	0.47	0.65		
Equity	Individual	0.92	0.87	0.44	0.29	0.11**	0.08**
	Class Mean	0.93	0.97	0.49	0.56		

** $p<0.01$

* $p<0.05$

The sample consisted of 594 students in 18 classes in Indonesia and 567 students in 18 classes in Australia.

The eta^2 statistic (which is the ratio of 'between' to 'total sums of squares) represents the proportion of variance explained by class membership.

Table 4.3 also shows that the discriminant validity (mean correlation of a scale with other scale) using the individual student as the unit of analysis ranges from 0.32 to 0.44 for Indonesian students and from 0.23 to 0.36 for Australian students. When using the class mean as the unit of analysis, the discriminant validity ranges from 0.30 to 0.61 for Indonesian students and from 0.46 to 0.70 for Australian students. These results suggest that raw scores on the WIHIC measure distinct, but somewhat overlapping, aspects of classroom environment (although the factor analysis results attest to the independence of factor scores).

4.2.4 Internal Consistency Reliability and Discriminant Validity of TOSRA

For the 20-item version of the TOSRA, the same two indices of scale reliability and validity were generated (see Table 4.4). The Cronbach alpha reliability coefficient was used as an index of scale internal consistency. The alpha coefficients for the three scales, using the individual student as the unit of analysis, are high and range from 0.66 to 0.77 for Indonesian students and from 0.59 to 0.74 for Australian students. With the class mean as the unit of analysis, the alpha reliability coefficients range from 0.36 to 0.91 for Indonesian students and from 0.83 to 0.89 for Australian students.

The discriminant validity of each scale was determined by calculating the mean correlation of each scale with the other two scales. These two analyses were performed both at the individual and at the class levels. A summary of these results is also presented in Table 4.4. The discriminant validity, using the individual student as the unit of analysis, ranges from 0.17 to 0.23 for Indonesian students and from 0.17 to 0.24 for Australian students. When using the class mean as the unit of analysis, the discriminant validity ranges from 0.10 to 0.23 for Indonesian students and from 0.24 to 0.32 for Australian students. This suggests that, using raw scores, scales of the TOSRA are largely independent and have only a modest level of overlap.

Table 4.4 Internal Consistency Reliability (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation With Other Scales) for Two Units of Analysis for the Modified TOSRA

Scale	No of Items	Unit of Analysis	Alpha Reliability		Mean Correlation with other Scales	
			Indonesia	Australia	Indonesia	Australia
Normality of Scientists	6	Individual	0.66	0.59	0.20	0.19
		Class Mean	0.64	0.83	0.26	0.32
Attitude to Scientific Inquiry	7	Individual	0.75	0.71	0.23	0.17
		Class Mean	0.36	0.85	0.22	0.24
Career Interest in Science	7	Individual	0.77	0.74	0.17	0.24
		Class Mean	0.91	0.89	0.10	0.26

The sample consisted of 594 students from 18 classes in Indonesia and 567 students from 18 classes in Australia.

4.2.5 Ability of WIHIC to Differentiate Between Classrooms

For the WIHIC, the ability of each scale to differentiate between the perceptions in different classes of students was investigated using a series of analyses of variance (ANOVAs). The one-way ANOVA for each scale involved class membership as the independent variable and the individual student as the unit of analysis. Table 4.3

shows that each WIHIC scale differentiates significantly ($p<0.05$) between classrooms for both Indonesian and Australian students.

The eta^2 statistic, which represents the proportion of the variance in environment scores accounted for by class membership, ranges from 0.05 to 0.14 for Indonesian students and from 0.05 to 0.12 for Australian students. The data presented in Table 4.3, in conjunction with the factor analysis results in Table 4.1 and the reliability results in Table 4.2, support the contention that the WIHIC questionnaire is a valid and reliable for the assessment of students' perceptions of their psychosocial classroom environments in both Indonesia and Australia. Therefore, teachers and researchers in Indonesia can use the WIHIC questionnaire with confidence in the future.

4.3 DIFFERENCES BETWEEN COUNTRIES AND GENDERS IN LEARNING ENVIRONMENT AND ATTITUDES TO SCIENCE

This section discusses the following:

- Differences between Australia and Indonesia in learning environment and attitudes to science (Section 4.3.1);
- Differences between male and female perceptions of their learning environment and attitudes to science (Section 4.3.2); and

- Country-by-gender interaction effects for learning environment and attitudes to science (Section 4.3.3).

As discussed in the methods chapter (see Section 3.7), country and gender differences in environment and attitudes were explored using two-way MANOVAs with repeated measures on one factor. The set of WIHIC scales constituted the dependent variables in the first MANOVA and the set of TOSRA scales constituted the dependent variables in the second MANOVA. The two independent variables were country and gender, with gender forming a repeated-measures factor.

The unit of analysis chosen was the within-class gender subgroup mean. Because boys and girls can be represented in disproportionate numbers in different coeducational classes, a separate mean for boys and a separate mean for girls were calculated for each class. Therefore, each class furnished a matched pair of means (repeated measures), consisting of the boys' mean and the girls' mean, for each scale.

Because both MANOVAs yielded statistically significant results overall for the set of dependent variables using Wilks' lambda criterion, univariate two-way ANOVAs were examined and interpreted for each individual WIHIC and TOSRA scale. Table 4.5 shows the F ratio obtained for each dependent variable for country, gender and the country x gender interaction. Because the interaction effect is statistically nonsignificant for seven of the nine scales in Table 4.5, it was decided to organize the discussion of results into three sections: country differences (Section 4.3.1); gender differences (Section 4.3.2); and country x gender interactions (Section 4.3.3).

Table 4.5 Two-Way ANOVA Results (*F* Ratio and Eta^2 Statistic) for Country and Gender Differences for Each Scale of the WIHIC and TOSRA

Scale	ANOVA Results					
	Country		Gender		Country x Gender	
	F	Eta^2	*F*	Eta^2	*F*	Eta^2
WIHIC						
Student Cohesiveness	0.58	0.03	20.00**	0.54	15.35**	0.48
Teacher Support	0.15	0.01	1.08	0.06	0.99	0.06
Involvement	5.95*	0.26	0.22	0.01	0.89	0.05
Investigation	64.39**	0.79	0.23	0.01	1.19	0.07
Task Orientation	62.50**	0.79	0.38	0.02	0.39	0.02
Equity	7.65*	0.31	8.67**	0.34	0.06	0.00
TOSRA						
Normality of Scientists	24.75**	0.59	4.59*	0.21	4.35*	0.20
Attitude to Scientific Inquiry	14.36**	0.46	0.05	0.00	0.01	0.00
Career Interest in Science	100.51**	0.86	5.43*	0.24	2.06	0.11

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

The sample consisted of 18 matched pairs of within-class gender means in Indonesia and another 18 matched pairs of within-class gender means in Australia.

4.3.1 Differences Between Australia and Indonesia in Learning Environment and Attitudes to Science

Table 4.6 reports the average item and average item standard deviation for each classroom environment and attitude scale for Australia and Indonesia. In order to estimate the magnitude of the differences between countries (in addition to their statistical significance), effect sizes were calculated as recommended by Thompson (1998a, 1998b). The effect sizes in Table 4.6 shows the magnitudes of the differences between countries expressed in standard deviation. Table 4.6 also repeats the ANOVA results from Table 4.5 to show the statistical significance of differences between countries on each scale.

The results of the quantitative probe into learning environments in Australia and Indonesia (Table 4.6) revealed that, for some scales (Involvement and Investigation), Indonesian students perceived their learning environments significantly more positively than did Australian students. However, for some other scales (Task Orientation and Equity), Australian students had significantly more positive perceptions of their classroom environment than their Indonesian counterparts.

Table 4.6 also shows that the effect size for six scales of the WIHIC questionnaire ranges between 0.12 and 0.69. These effect sizes suggest a fairly substantial difference between countries on the two learning environment scales of Investigation and Task Orientation (around two thirds of a standard deviation).

Table 4.6 also indicates that Indonesian students have higher scores for Normality of Scientists and Career Interest in Science than Australian students, but lower scores for Attitude Towards Scientific Inquiry relative to Australian students. There is a statistically significant (p<0.01) difference between the Indonesian and Australian attitudes on all of the three TOSRA scales. The effect sizes for three scales of the

TOSRA range between 0.24 to 1.00. These effect sizes suggest a substantial difference between countries on students' attitudes to science on two scales.

Table 4.6 Average Item Mean, Average Item Standard Deviation, and Difference between Indonesian and Australian Students (Effect Size and ANOVA Results) on the WIHIC and TOSRA Using the Individual as the Unit of Analysis

Scale	Average Item Mean		Average Standard Deviation		Difference	
	Indonesia	Australia	Indonesia	Australia	Effect Size	*F*
WIHIC						
Student Cohesiveness	3.74	3.81	0.64	0.52	0.12	0.58
Teacher Support	3.05	2.93	0.87	0.61	0.16	0.15
Involvement	2.95	2.85	0.76	0.66	0.14	5.95*
Investigation	3.01	2.51	0.72	0.72	0.69	64.39**
Task Orientation	3.33	3.74	0.72	0.57	0.64	62.50**
Equity	3.51	3.61	0.88	0.72	0.13	7.65*
TOSRA						
Normality of Scientists	2.45	2.31	0.66	0.49	0.24	24.75**
Attitude Towards Scientific Inquiry	2.53	3.31	0.75	0.54	1.21	14.36**
Career Interest in Science	3.51	2.81	0.78	0.62	1.00	100.51**

* $p<0.05$
** $p<0.01$
The sample consisted of 594 students in 18 classes in Indonesia and 567 students in 18 classes in Australia.

Figure 4.1 depicts in a graphical form the differences between Indonesian and Australian students in learning environment and attitudes to science. This graph demonstrates that Indonesian students have more favourable attitudes and learning environment scores on some scales, whereas Australian students have more favourable scores on others.

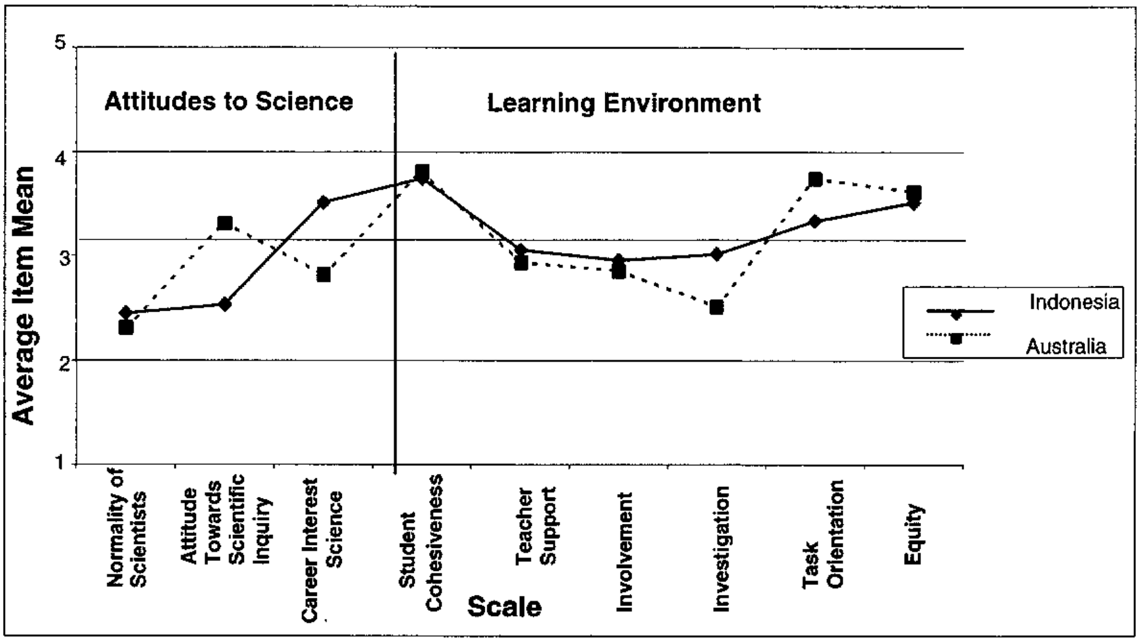

Figure 4.1 Differences Between Indonesian and Australian Students' Perceptions on the WIHIC and TOSRA

4.3.2 Differences Between Males and Females in Learning Environment and Attitudes to Science

Table 4.7 reports the differences in average item mean for scores on each environment and attitude scale for male and female students. *F* ratios from Table 4.5 are repeated in Table 4.7 to show the statistical significance of gender differences. Effect sizes are also shown in Table 4.7. The results in Table 4.7 reveal that female students perceived significantly more Cohesiveness and Equity than did male students.

Table 4.7 Average Item Mean, Average Item Standard Deviation and Difference between Male and Female Students' Perceptions on the WIHIC and TOSRA (Effect Size and *F* Ratio) Using the Individual as the Unit of Analysis

Scale	Average Item Mean		Average Standard Deviation		Difference	
	Male	Female	Male	Female	Effect Size	*F*
WIHIC						
Student Cohesiveness	3.69	3.88	0.24	0.25	0.78	20.00**
Teacher Support	2.98	2.92	0.24	0.36	0.20	1.08
Involvement	2.88	2.93	0.20	0.30	0.20	0.22
Investigation	2.73	2.74	0.35	0.39	0.03	0.23
Task Orientation	3.50	3.52	0.32	0.36	0.06	0.38
Equity	3.42	3.57	0.31	0.34	0.46	8.67**
TOSRA						
Normality of Scientists	2.48	2.41	0.30	0.19	0.29	4.59*
Attitude Towards Scientific Inquiry	2.45	2.44	0.26	0.25	0.04	0.05
Career Interest in Science	3.07	3.25	0.42	0.48	0.40	5.43**

* $p<0.05$
** $p<0.01$
The sample consisted of 594 students in 18 classes in Indonesia and 567 students in 18 classes in Australia.

Table 4.7 shows that the effect sizes for six scales of the WIHIC questionnaire range between 0.03 to 0.78. These effect sizes suggest a fairly substantial difference between genders for the learning environment scales of Student Cohesiveness and Equity.

The results in Table 4.7 for TOSRA indicate that male students have significantly higher Normality of Scientists scores but significantly lower Career Interest in Science scores than females.

Figure 4.2 graphically depicts the differences between male and female students' perceptions in learning environment and attitudes to science. Generally, differences between genders (Figure 4.2) are smaller than differences between countries (see Figure 4.1).

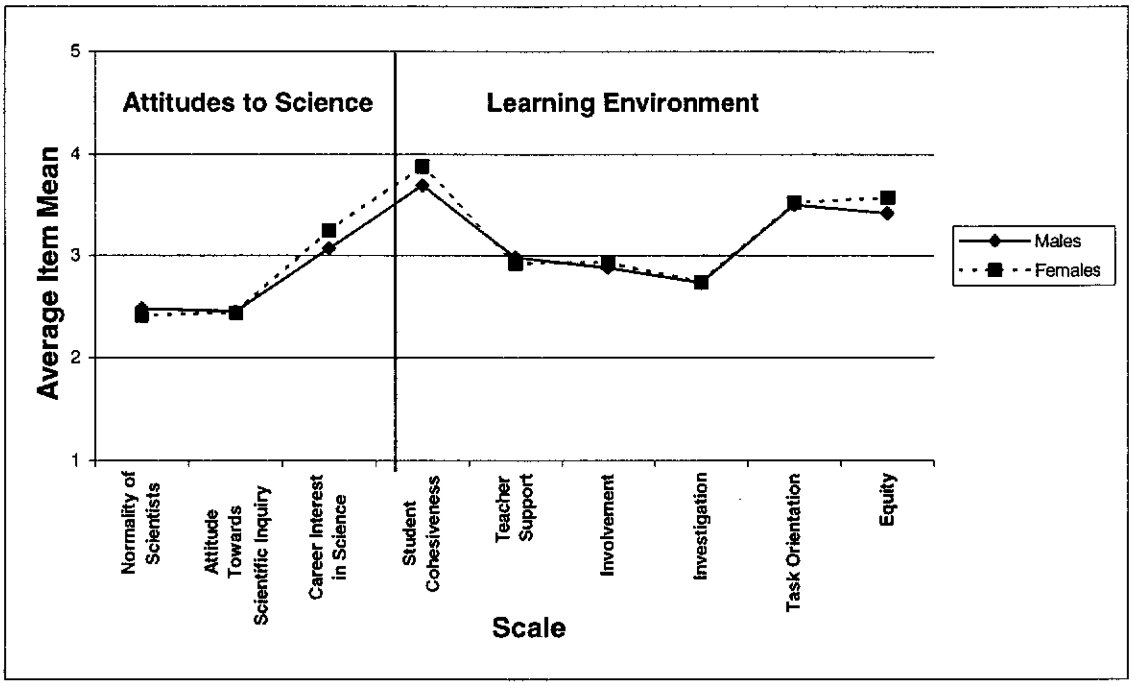

Figure 4.2 Difference Between Male and Female Students' Perceptions on the WIHIC and TOSRA

4.3.3 Country-by-Gender Interaction Effects

The results in Table 4.5 shows that a statistically significant country x gender interaction emerged for only two of nine environment and attitude scales, namely, Student Cohesiveness and Normality of Scientist. Therefore, the independent interpretation of country differences (Section 4.3.1) and gender differences (Section 4.3.2) are valid for all scales except these two scales. In this subsection, the two significant country x gender interactions in Table 4.5 are interpreted.

The eta^2 statistic was calculated to provide an estimate of the strength of association between each effect (country membership, gender and the interaction) for each WIHIC and TOSRA scale. For example, Table 4.5 shows that the amount of variance in scores accounted for by country membership (i.e. eta^2) ranged from 0.01 to 0.79 for WIHIC scales and from 0.46 to 0.86 for TOSRA scales. For the two statistically significant interactions, the amount of variance accounted for is 0.48 for Student Cohesiveness and 0.20 for Normality of Scientists.

Figures 4.3 and 4.4 were produced to interpret the statistically significant country x gender interaction for the two scales of Student Cohesiveness and Normality of Scientists.

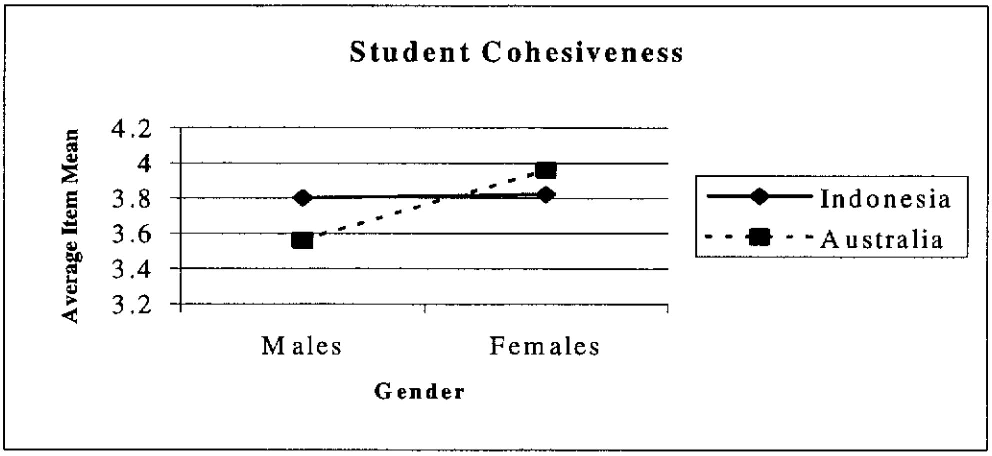

Figure 4.3 Interaction between Country and Gender for Student Cohesiveness

The interpretation of the country x gender interaction in Figure 4.3 for Student Cohesiveness is that, whereas Indonesian males perceive the same level of cohesiveness as do Indonesian females, Australian females perceive more cohesiveness than do Australian males.

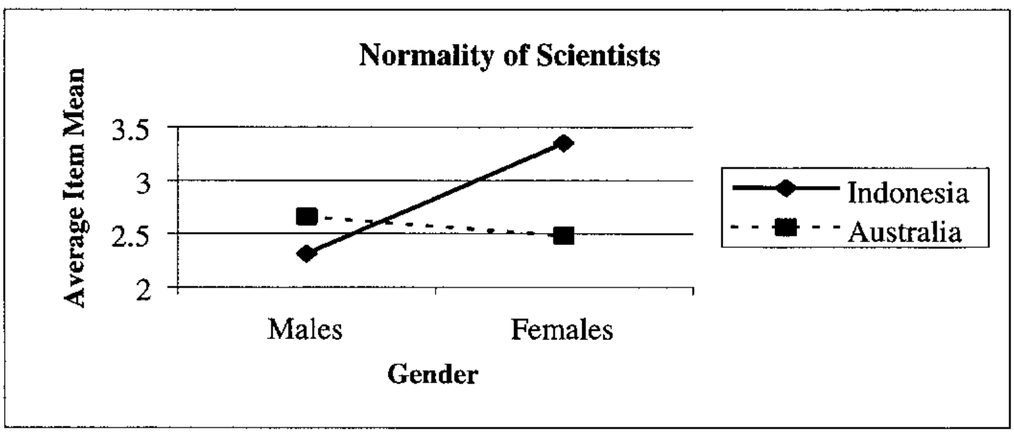

Figure 4.4 Interaction between Country and Gender for Normality of Scientists

An interesting interaction between country and gender also occurred for the TOSRA scale of Normality of Scientists. Figure 4.4 shows that the Indonesian males have lower Normality of Scientists scores than do Australian males, whereas Indonesian females have higher Normality of Scientists scores than do Australian females.

4.3.4 Explanation of Differences Between Countries and Genders

Qualitative survey data, in conjunction with multivariate statistical analysis, have proved useful in identifying interesting between-country and between-genders differences in classroom environment perceptions and attitudes to science (see sections 4.3.1 – 4.3.3). However, these research methods do not help to explain the reasons for these differences. Therefore, a limitation of my study is that explanations for differences were not sought through the use of qualitative data-gathering methods. Clearly, the use of qualitative methods is desirable in future research.

In the absence of insights from qualitative research, it would be highly speculative to guess at explanations for these differences. In a somewhat similar cross-national study of learning environment and student attitudes in Taiwan and Australia, Aldridge and Fraser (2000) did employ detailed qualitative methods of observation and interview. Through the use of this qualitative information, they identified that some possible explanations for between-country differences. Such differences, which appeared to influence the types of learning environment created by teachers, included the types of pressures experienced by teachers, the educational aims and nature of the curriculum, the expectations held by students and parents, and the degree of respect that students held for their teachers.

It is recommended that future cross-national studies employ some of the qualitative methods used by Aldridge and Fraser (2000) in an attempt to explain any differences found between countries or genders in my study in Indonesia.

4.4 ASSOCIATIONS BETWEEN LEARNING ENVIRONMENT AND STUDENT ATTITUDES TO SCIENCE

Associations between students' perceptions of the classroom environment (as assessed by the WIHIC questionnaire and their attitudes to science as assessed by TOSRA) are reported in Table 4.8. These associations were investigated using the sample of 1,161 students (594 from Indonesia and 567 from Australia), in 18 classes for each of Indonesia and Australia. All analyses were performed separately for the Indonesian sample and the Australian sample. The individual was used as the unit analysis. The following two main methods of analysis were used:

1. Simple correlation analysis of bivariate relationships between each attitude measure and each individual environment scale; and

2. Multiple regression analysis of the joint relationship between each attitude measure and the whole set of six environment scale.

The simple correlation analysis is a suitable method for examining relationships between two specific variables. The multiple regression analysis provides information about the association between an attitude scale and the set of six environment scales. It provides a more parsimonious picture of the joint influence of correlated environment scales on an attitude outcome.

Table 4.8 Simple Correlation and Multiple Regression Analyses for Associations between Attitudes and Classroom Environment Using the Individual as the Unit of Analysis

Scale	Normality of Scientists				Attitude to Scientific Inquiry				Career Interest in Science			
	r		*β*		*r*		*β*		*r*		*β*	
	Indo	Aust	Indo	Aust	Indo	Aust	Indo	Aust	Indo	Aust	Indo	Aust
Student Cohesiveness	0.19**	0.17**	0.09*	0.06	0.10*	0.10*	0.02	0.04	0.01	0.00	-0.17**	-0.13**
Teacher Support	0.27**	0.18**	0.15**	0.03	0.16**	0.13**	0.09	0.01	0.27**	0.29**	0.18**	0.20**
Involvement	0.13**	0.19**	-0.01	0.09	0.14**	0.20**	0.06	0.15	0.24**	0.23**	0.15**	0.11*
Investigation	0.09*	0.10*	-0.11*	-0.02	0.11**	0.12**	0.00	0.06	0.23**	0.28**	0.09	0.16**
Task Orientation	0.32**	0.28**	0.03	0.22**	0.14**	0.11**	0.03	0.07	0.18**	0.20**	-0.03	0.09
Equity	0.19**	0.22**	0.25**	0.04	0.14**	0.06	0.06	-0.04	0.25**	0.15**	0.14**	0.01
Multiple Correlation (*R*)			0.36**	0.33**			0.20**	0.22**			0.37**	0.38**

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

Using the standardised regression coefficients (*β*), the environment scales which contributed uniquely and significantly to the explanation of the variance in the attitudes to science were identified. For example, the standardised regression coefficients identify the specific environment scales that make a significant contribution to explaining the variance in the attitudinal outcomes when the other environment scales are mutually controlled.

This subsection discusses the following:

- Simple correlation analyses for Normality of Scientists (Section 4.4.1);
- Multiple Regression Analyses for Normality of Scientists (Section 4.4.2);
- Simple correlation analyses for Attitude to Scientific Inquiry (Section 4.4.3);
- Multiple Regression Analyses for Attitude to Scientific Inquiry (Section 4.4.4);
- Simple correlation analyses for Career Interest in Science (Section 4.4.5); and
- Multiple Regression Analyses for Career Interest in Science (Section 4.4.6).

4.4.1 Simple Correlation Analyses for Normality to Scientists

With the individual student as the units of analysis, Table 4.8 shows that all of the environment scales are statistically significantly correlated with Normality of Scientist for both Indonesian and Australian students. An inspection of the signs for the significant correlations for Normality to Scientist in Table 4.8 showed that positive correlations were found in all cases.

4.4.2 Multiple Regression Analyses for Normality to Scientists

Table 4.6 shows a statistically significant multiple correlation (R) ($p<0.01$) between the Normality of Scientists and the set of the environment scales of 0.36 for Indonesian students and 0.33 for Australian students.

In order to interpret the significant multiple correlations, the standardised regression coefficients were examined. Table 4.8 shows that the number of significant standardized regression coefficients (β) was four for Indonesian students and one for Australian students ($p<0.05$).

Inspection of the signs for the significant standardised regression coefficients in Table 4.8 show that, for Indonesian students, the relationship between Normality of Scientists and the environment scales of Student Cohesiveness, Teacher Support and Equity are positive. That is, Student Cohesiveness, Teacher Support and Equity are independent predictors of Normality of Scientists scores when all other WIHIC scales are actually controlled. However, a negative regression weight was found for the environment scale of Investigation. Although Investigation might be present in Indonesian students' classrooms, it might not be welcome by the students and/or the teachers. Thus, increasing Investigation could be associated with lower Normality of Scientists scores.

Inspection of the significant standardised regression coefficients in Table 4.8 shows that, for Australian students, only Task Orientation was as significant independent predictor of Normality score. The sign of this relationship is positive.

4.4.3 Simple Correlation Analyses for Attitude to Scientific Inquiry

Table 4.8 shows that the simple correlation between each environment scale and Attitude to Scientific Inquiry is statistically significant for all six environment scales in Indonesia and for five environment scale in Australia. The only exception is Equity for the Australian sample. An examination of the signs of the simple correlations for Attitude to Scientific Inquiry shows that, for students in both Indonesia and Australia, all associations are positive.

4.4.4 Multiple Regression Analyses for Attitude to Scientific Inquiry

From Table 4.8, the multiple correlations (R) for Attitude to Scientific Inquiry suggest that the association of students' attitudes to the whole set of six environment scales is statistically significant ($p<0.01$) both for the Indonesian sample and the Australian sample. The magnitude of the multiple correlation was 0.20 for Indonesian students and 0.22 for Australian students.

However, the standardised regression coefficient (β) is not statistically significant for any WIHIC scale for either Indonesian or Australian students. It seems that the relatively weak association between the set of the environment scales and Attitude to Scientific Inquiry is not explained by the strong influence of a specific WIHIC scale or scales.

4.4.5 Simple Correlation Analyses for Career Interest in Science

Table 4.8 shows that the simple correlation between each environment scale and Career Interest in Science is statistically significant (*r*) ($p<0.05$) for five of six environment scales both in Indonesian and Australia. The only exception is Student Cohesiveness for both the Indonesian and Australian sample. An inspection of the signs for the significant correlations for Career Interest in Science showed that a positive relationship exists for all the environment scales for both Indonesian and Australian students.

4.4.6 Multiple Regression Analyses for Career Interest in Science

From Table 4.8, the significant multiple correlation (*R*) ($p<0.01$) between Career Interest in Science and the set of the environment scales is 0.37 for Indonesian students and 0.38 for Australian students. The number of significant standardised regression coefficients (β) is four for both Indonesian and Australian sample (Table 4.8).

Inspection of the signs for the significant standardised regression coefficients for Indonesian students shows that most of the relationships between Career Interest in Science and the environment scales are positive. The only exception is a negative regression weight for the environment scale of Student Cohesiveness for both the Indonesian and Australian samples. Career Interest in Science is greater in Indonesian classrooms with greater Teacher Support, Involvement and Equity, and greater in Australian classrooms with greater Teacher Support, Involvement and Investigation. Overall, Table 4.8 suggests that Teacher Support and Involvement are the strongest independent predictors of student attitudes to science in both Indonesia and Australia.

4.5 CONCLUDING REMARKS

The present study involved the administration of two questionnaires, the WIHIC (What Is Happening In This Class?) questionnaire and the TOSRA (Test of Science-Related Attitude) questionnaire, Indonesia and Australia. The WIHIC questionnaire was used to assess students' perceptions of their classroom learning environment and the TOSRA questionnaire was used to assess students' attitudes to science. Both questionnaires had to be translated (and back translated) into Indonesian before their administration in the Indonesian classrooms. The data were collected from 1,161 students in a total of 36 classes (18 Indonesian classes and 18 Australian classes). All classes were coeducational and the number of boys (584) was slightly higher than the number of girls (577). This chapter has presented the analyses and results for the data collected for the present study. The data were analysed (using the SPSS package) to answer this study's research questions.

To examine the reliability of WIHIC and TOSRA, factor analyses, item analyses, internal consistency reliability, discriminant validity and one-way ANOVA for class membership differences were used. A series of principal components factor analysis resulted in the acceptance of a version of WIHIC comprising 55 items in 6 scales and a version of TOSRA comprising 20 items in 3 scales. The total amount of variance accounted for by these factors for the WIHIC was 46% for the Indonesian sample and 41% for the Australian sample and for the TOSRA was 31% for the Indonesian sample and 28% for the Australian sample.

Using the individual as the unit of analysis, the Cronbach alpha reliability ranged from 0.82 to 0.92 in Indonesia and from 0.78 to 0.89 in Australia. The range using the class mean as the unit of analysis was from 0.75 to 0.95 in Indonesia and from 0.88 to 0.97 in Australia. The Cronbach alpha reliability of the TOSRA questionnaire ranged from 0.66 to 0.77 in Indonesia and from 0.59 to 0.74 in Australia using the individual as the unit of analysis. When the class mean was used as the unit of analysis, the Cronbach alpha reliability was between 0.36 to 0.91 in Indonesia and between 0.83 to 0.89 in Australia.

The discriminant validity results (mean correlation of a scale with the other scales) obtained for the WIHIC questionnaire ranged from 0.32 to 0.44 in Indonesia and ranged from 0.23 to 036 in Australia for the individual unit of analysis. When the class mean was used as the unit of analysis, the range was from 0.30 to 0.61 in Indonesia and from 0.46 to 0.70 in Australia. The discriminant validity results obtained for the TOSRA questionnaire ranged from 0.17 to 0.23 in Indonesia and from 0.17 to 0.24 in Australia using the individual as the unit of analysis. When the class mean was used as the unit of analysis, the range in Indonesia was from 0.10 to 0.26 while it was from 0.24 to 0.32 in Australia.

The results of the analysis of variance (ANOVA) from the data obtained from the WIHIC questionnaire (see Table 4.3) indicate that each WIHIC scale differentiated significantly ($p<0.05$) between classrooms for both Indonesia and Australian students. The eta^2 statistic, which represents the proportion of the variance in environment scores accounted for by class membership, ranged from 0.05 to 0.14 for Indonesian students and from 0.05 to 0.12 for Australian students.

Overall these results suggest that both the WIHIC questionnaire and the TOSRA are valid and reliable instruments that can be used with confidence for the assessment of, respectively, students' perceptions of their psychosocial classroom environment and their attitudes to science in both Indonesia and Australia.

In order to answer the second research question, country and gender differences in environment and attitudes were explored using two-way MANOVAs. The set of WIHIC scales constituted the dependent variables in the first MANOVA and the set of

TOSRA scales constituted the dependent variables in the second MANOVA. Because both MANOVAs yielded statistically significant results overall for the set of dependent variables using Wilks' lambda criterion, univariate two-way ANOVAs were examined and interpreted for each individual WIHIC and TOSRA scale.

For some scales (Involvement and Investigation), Indonesian students perceived their learning environment significantly more positively than did Australian students. However, for some other scales (Task Orientation and Equity), Australian students had significantly more positive perceptions of their classroom environment than their Indonesian counterparts. Although Indonesian students have significantly higher scores for Normality of Scientists and Career Interest in Science than Australian students, they have lower scores for Attitude Towards Scientific Inquiry. The effect sizes for these five scales for which between-country differences were statistically significant range from 0.13 to 1.00 standard deviations.

Analysis of data related to gender (Table 4.7) revealed that male students perceived significantly more Teacher Support and Equity than did females. The results also indicate that male students have significantly higher Normality of Scientists scores but significantly lower Career Interest in Science scores than females. Effect sizes, ranging from 0.29 to 0.78 for scales exhibiting significant differences, suggest a fairly substantial difference between genders.

An interesting interaction between country and gender occurred for the WIHIC scale of Students Cohesiveness and for the TOSRA scale of Normality of Scientists. Figure 4.3 shows that Australian females have higher Student Cohesiveness scores than Australian males, but that gender differences in Student Cohesiveness are negligible for Indonesian students. Figure 4.4 shows that Indonesian males have lower Normality of Scientists scores than do Australian males, whereas Indonesian females have high Normality of Scientists scores than do Australian males.

Simple correlation and multiple regression analyses were conducted to determine the strength of associations between the six scales of the WIHIC questionnaire (Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation and Equity) and the three scales of the TOSRA (Normality of Scientists, Attitude to Scientific Inquiry and Career Interest in Science). There was a statistically significant simple correlation ($p<0.05$) between Normality of Scientists and all of the six WIHIC scales for both the Indonesian sample and Australian sample with the individual used as the unit of analysis. The correlation between Attitude to Scientific Inquiry and the six scales of WIHIC was statistically significant for Indonesian students for all six scales and for Australian students for five scales (besides Equity). The correlation between Career Interest in Science and the scales of WIHIC was statistically significant for five scales for both Indonesian students and Australian students (besides Student Cohesiveness).

The multiple regression analysis for each of the three TOSRA involved the association of students' perceptions of the learning environment for Indonesia and Australia students with respect to the whole set of six environment scales. A significant multiple correlation ($p<0.01$) was found between each attitude scale and the set of WIHIC scales for both Indonesia and Australia. An inspection of the regression coefficients suggests that, in both Indonesia and Australia, student attitudes to science are more positive in classrooms with greater Teacher Support and Involvement. Overall, the present findings of associations between students' attitudes and their perceptions of their classroom learning environment replicate considerable prior research in a range of countries (Fraser, 1998a).

Chapter 5

CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

5.1 INTRODUCTION

In this chapter, I present conclusions and implications from my research. Also, I discuss the limitations of both the study and the methods used. Finally, I propose future research directions that are suggested by this study and its findings.

This study was entirely quantitative and relied on results obtained from two questionnaires, namely, the *What Is Happening In This Class?* (WIHIC) questionnaire and the *Test of Science-Related Attitude* (TOSRA). Samples were selected and questionnaire administration took place on a relatively large scale in two countries, namely, Australia and Indonesia. The questionnaires were translated and back translated and administered in private coeducational schools in two different areas in each country. In Australia, the samples came from Sydney, New South Wales and from Perth, Western Australia. In Indonesia, the samples came from Jakarta, Java and Singaraja, Bali.

My concluding discussion is presented under the following headings:

- Summary of the five chapters of this thesis (Section 5.2);
- Implications of findings from the study (Section 5.3);
- Constraints and limitations of the study (Section 5.4);
- Distinctiveness and contributions of the study (Section 5.5);
- Suggestions for future research (Section 5.6); and
- Conclusion (Section 5.7).

5.2 SUMMARY OF THIS THESIS

Chapter 1, on the rationale for the study, discussed the background of the present research and outlined the purposes of the study, including the following research questions:

1. Is it possible to validate English and Indonesian versions of the *What Is Happening In This Class?* (WIHIC) questionnaire and the *Test of Science-Related Attitude* (TOSRA) for use in Australia and Indonesia?

2. Do students' scores on the *What Is Happening In This Class?* (WIHIC) questionnaire and *Test of Science-Related Attitude* (TOSRA) vary with:
   (a) country (Australian and Indonesia);
   (b) gender?

(c) What is the strength of associations between students' perceptions of their classroom environment and their attitudes to science in Australia and Indonesia?

Chapter 1 also gave a brief description of the educational systems of both Australia and Indonesia. It pointed out some of the limitations of the study, while stressing its significance. The chapter closed with an overview of the organisation of the various chapters in the thesis.

In the light of the major purposes of the present study, as stated in the research questions (Section 1.3), Chapter 2 reviewed literature in several sections: definition of key terms and concepts; research approaches for investigating classroom environments; unit of statistical analysis; pioneering research on classroom environment; learning environment instruments; attitude-measuring techniques and instruments; and review of past research on learning environments.

As a major thrust of the present study was to investigate relationships between classroom environment and attitudes, literature related to attitudes was also reviewed. As this study was cross-national and involved Australian and Indonesia, I focused my literature review on both earlier and recent studies of classroom environment in the Southeast Asian region. Literature on the few recent cross-national studies of classroom environment was also reviewed in Chapter 2.

As gender differences in students' perceptions of classroom environment and in students' attitudes to science were also a part of my three research questions, relevant gender studies also were reviewed in Chapter 2.

Chapter 3 on research methods provided information about procedural aspects of the present study, whose research design was basically a quantitative one using a questionnaire survey involving students' perceptions. Because I was interested in both students' perceptions of their classroom environments and students' attitudes to science, two modified questionnaires were used to collect the data: the *What Is Happening In This Class?* (WIHIC) questionnaire; and the *Test of Science-Related Attitudes* (TOSRA).

In addition to justifying the choice of the instruments, Chapter 3 discussed the reasons for the choice of countries, schools and grade levels. The school samples and student samples (1,161 students in 18 Indonesian classes and 18 Australian classes) were also considered in this chapter.

Chapter 3 also described the statistical analysis procedures employed. For the cross-validation of the questionnaires, factor and item analyses were chosen. Cronbach's alpha reliability coefficient and ANOVAs for class membership differences in student perceptions were chosen to provided further evidence of scale validity and reliability. For the investigation of associations between environments and attitudes, the two methods of statistical analysis chosen were simple correlation analysis and multiple regression analysis. A two-way MANOVA, followed by an individual ANOVA for each environment and attitude scale, tested differences between countries and genders in terms of students' perceptions of classroom environments and in their attitudes to science.

Careful translations and back translations of both instruments were made prior to their administration in each country. The final 80-item version of the WIHIC questionnaire and the final version of the 70-item version of the TOSRA questionnaire were administered to a sample of 594 grade 9 and grade 10 science students from 18 classes in 8 schools in Indonesia and 567 students grade 9 and 10 science students from 18 classes in 8 schools in Australia. Samples from both countries were drawn from private, coeducational schools in two areas of each country.

Chapter 4 reported the data analyses and findings of the present study. The chapter focused on the following fundamental concerns:

1. Cross-validation of the *What Is Happening In This Class?* (WIHIC) questionnaire and the *Test of Science-Related Attitude* (TOSRA) questionnaire;

2. Country and gender differences in students' perceptions of classroom environments and students' attitudes to science; and

3. Associations between students' perceptions of their psychosocial classroom environments and students' attitudes to science.

The data collected from the 36 classes in Australia and the 36 classes in Indonesia were analysed in various ways to investigate the reliability and validity of the 80-item version of the WIHIC questionnaire and the 70-item version of the TOSRA in both countries to answer research question 1:

Is it possible to validate English and Indonesian versions of the WIHIC (What Is Happening In This Class?) questionnaire and the TOSRA (Test of Science Related Attitude) for use in Australia and Indonesia?

Principal components factor analysis followed by varimax rotation resulted in the acceptance of a revised version of the classroom environment instrument comprising 55 items in six scales. The *a priori* factor structure of the final version of the questionnaire was replicated in both countries, with nearly all items loading on their *a priori* scale and no other scale. For most items on both the Indonesian and English versions, the factor loadings were greater than 0.30. Also, for the TOSRA, a three-factor solution was found.

The internal consistency reliability (Cronbach alpha coefficient) was calculated for each of the six scales of the WIHIC for two units of analysis (individual and class mean). Using the class mean as the unit of analysis, scale reliability estimates ranged from 0.88 to 0.97 in Australia and from 0.75 to 0.95 in Indonesia. The internal consistency was also calculated for the attitude scale. Using the class mean, the reliability of different scales ranged from 0.83 to 0.89 in Australia and from 0.36 to 0.91 in Indonesia.

An analysis of variance (ANOVA) was used to determine the ability of each WIHIC scale to differentiate between the perceptions of students in different classes. The eta^2 statistic was calculated to provide an estimate of the strength of association between class membership and the dependent variable (WIHIC scale). Each scale differentiated significantly between classes ($p<0.01$) in both Indonesia and Australia. The amount of variance in scores accounted for by class membership (i.e. eta^2) ranged from 0.05 to 0.14 for Indonesia and from 0.05 to 0.12 for Australia for different WIHIC scales.

Having considered the validity and reliability of the two questionnaires (WIHIC and TOSRA) satisfactory for both countries, statistical analysis of the data were then used to seek answers to the next research question (research question 2):

> *Do students' scores on the What Is Happening In This Class? (WIHIC) questionnaire and Test of Science-Related Attitude (TOSRA) vary with:*
>
> *(a) country (Australia and Indonesia) and*
>
> *(b) gender?*

A two-way MANOVA revealed that Indonesian and Australian students had rather similar perceptions of their classroom environments in terms of Student Cohesiveness and Teacher Support. When it came to Involvement and Investigation, Indonesian students had more positive perceptions of their classroom learning environments than Australian students. But Indonesian students' perceptions of Task Orientation and Equity were less positive than for their Australian counterparts. As far as attitudes to science are concerned, Australian students had more positive attitudes towards Scientific Inquiry than Indonesian students, while Indonesian students had higher Normality of Scientists and Career Interest in Science scores than Australian students.

Regarding gender differences, the results were statistically significant for two learning environment scales and two attitude scales. Relative to boys, girls scores were higher on Student Cohesiveness, Equity, and Career Interest in Science, but were lower on Normality of Scientists.

Simple correlation and multiple regression analyses were used to answer the third and final research question (research question 3).

> *What is the strength of the associations between students' perceptions of their classroom environment and their attitudes to science in Australia and Indonesia?*

Results of the simple correlation show, on the whole, a reasonably strong and positive association between all the environment scales (Student Cohesiveness, Teacher

Support, Involvement, Investigation, Task Orientation and Equity) and the attitude scales (Normality of Scientists, Attitude to Scientific Inquiry and Career Interest in Science).

There were, however, a few negative associations. For example, a negative regression weight was found for the weak association between environment scale of Investigation and the attitude scale of Normality of Scientists for the Indonesian sample. Although Investigation might be present in Indonesian students' classrooms, it might not be welcome by the students. Thus increasing Investigation could be associated with lower Normality of Scientist scores. However, these findings suggest the desirability of replication in future studies.

5.3 IMPLICATIONS OF THE FINDINGS FROM THE STUDY

The subsections that follow discuss implications of the findings in terms of the applications of the instruments used in this study, namely, the *What Is Happening In This Class?* (WIHIC) questionnaire and the *Test of Science-Related Attitude* (TOSRA), country and gender differences in students' perceptions of classroom environments and students' attitudes to science, and associations between students' perceptions of classroom environments and their attitudes to science.

5.3.1 Cross-Validation of the *What Is Happening In This Class?* (WIHIC) Questionnaire and *Test of Science-Related Attitude* (TOSRA)

Based on the findings from factor and item analyses, as well as information about the internal consistency reliability (Cronbach alpha coefficient) and ability of the scales to differentiate between the perceptions of students in different classes (ANOVA), the WIHIC questionnaire was found to be a valid and reliable instrument. Thus, the WIHIC questionnaire can be used with confidence for the assessment of the psychosocial environments of science classes in secondary schools in Indonesia. Although the questionnaire was originally validated for science classes in Australia, its cross-validation in the present study for science classes in Indonesia is indicative that this questionnaire is indeed versatile and is likely to be suitable for use in a wide variety of learning environments with minimal adaptation. Hence, the WIHIC questionnaire has considerable potential for a variety of future uses.

Factor and item analyses, together with information about the internal consistency reliability (Cronbach alpha reliability), also suggest that the *Test of Science-Related Attitude* (TOSRA) questionnaire is a valid and reliable instrument that can be used in the future in Indonesia. The only problem, however, was that only three out of the seven original scales could be used with confidence in both countries, namely, Australia and Indonesia (see factor analysis of TOSRA reported in Section 4.4.2).

5.3.2 Country and Gender Differences in Students' Perceptions of Classroom Environment and Students' Attitudes to Science

Country and gender differences in environment and attitudes were explored using two-way MANOVA with repeated measures on one factor. The set of WIHIC scales constituted the dependent variables in the first MANOVA and the set of TOSRA scales constituted the dependent variables in the second MANOVA. The two independent variables were country and gender, with gender forming a repeated-measures factor (as the within-class gender mean was used as the unit of analysis).

As both MANOVAs yielded statistically significant results overall for the set of dependent variables using Wilks' lambda criterion, the univariate two-way ANOVA was examined and interpreted for each individual WIHIC and TOSRA scales. Table 4.5 shows the *F* ratio obtained for each dependent variable for country, gender, and the country x gender interaction. The interaction effect was found to be statistically nonsignificant for seven of the nine scales (see Table 4.5).

Table 4.6 reported the average item and average item standard deviation for each classroom environment scale and attitude scale for Australia and Indonesia. In order to estimate the magnitude of the differences between countries (in addition to their statistical significance) the effect sizes were also calculated in terms of the difference in means expressed in standard deviation units. For some scales (Involvement and Investigation), Indonesian students perceived their learning environments significantly more positively than did Australian students. However, for some other scales (Task Orientation and Equity) Australian students had significantly more positive perceptions of their classroom environment than their Indonesian counterparts.

The graph of Figure 4.1 depicting the differences between Indonesian and Australian students in learning environment and attitude to science demonstrates that Indonesian students have more favourable attitudes and learning environment scores on some scales, whereas Australian students have more favourable scores on others.

Results from Table 4.7 revealed that female students perceived significantly more Cohesiveness and Equity than did male students. These results also indicated that male students have significantly higher Normality of Scientists scores but lower Career Interest in Science scores than females.

The interpretation of the country x gender interaction in Figure 4.3 for Student Cohesiveness is that, wherever Indonesian males, Indonesian females perceive less cohesiveness than Australian females. It was also found (see Figure 4.4) that Indonesian males have lower Normality of Scientists scores than do Australian males, whereas Indonesian females have higher Normality of Scientists scores than do Australian females.

5.3.3 Associations between Students' Perceptions of Classroom Environment and Students' Attitudes to Science in Australia and Indonesia

The findings resulting from the statistical analyses, as tabulated in Table 4.8 and described in detail in Section 4.4, and summarised at the end of Section 5.2 above, describe a reasonably strong statistically significant association between most of the Environment Scales, (related to students' perceptions of their classroom environment), and the Attitude Scales, (related to students' attitude to science). Exceptions were between Investigation (Environment Scale) and Normality of Scientists (Attitude Scale).

These findings imply that there is a relationship between the way students perceive their classroom environment and the attitude they develop towards science. The more conducive their classroom environment is the more positive their attitudes towards science tend to be.

Anomalies and/or differences found in the findings could be due to the fact that science teachers, both in Australia and Indonesia, have still not been able to encourage their students to be "investigative" and therefore able to design, perform their own experiments and develop a greater appreciation of the scientific method of science and of scientists.

5.4 CONSTRAINTS AND LIMITATIONS OF THE STUDY

In interpreting the findings from the present study, several factors should be considered:

1. The size and nature of the sample were limited. As both Australia and Indonesia are large countries spread over thousands of kilometres with a population of around 20 million and 200 million, respectively, it was not possible to get a sample representative of each country. For example, Australia is made up of six states, each with its own educational system and own curriculum. Indonesia is made up of five large islands each with its own characteristics but with the same educational (national) system.

2. The sample came from coeducational private schools, and so we do not know about the responses from single-sex, government schools. Therefore, it is not clear whether the findings from the present study can be generalised more widely beyond the specific samples involved.

3. The interpretation of the translated versions of the two questionnaires (WIHIC and TOSRA) used for the survey could pose a problem especially for the Indonesian students. Some words and concepts could have slightly different meanings and/or implications compared with the original English version. This could have affected the responses to a certain extent. The

Australian students, therefore, would have a slight advantage as they were presented the original versions of the questionnaire, written in their native language.

4. There is quite a difference between an Indonesian science curriculum and an Australian science curriculum. The Indonesian science curriculum tends to be content-oriented with students often being required to learn by rote and to remember a large amount of factual information, which is meticulously tested usually by multiple-choice question during the annual national examinations. In Australia, however, the science curriculum is more skills-based and students are encouraged to develop skills like observing, recording, analyzing data, experimenting and so on. So, it could be that Australian students encourage their teachers to use investigations and get more involved in science activities and thus score higher on the environment scale of Investigation and Involvement. Also, due to the economic differences between Indonesia and Australia, Australian students could find it is easier to contemplate choosing a scientific career thus scoring higher on the attitude scale Career Interest in Science.

5. The timing of the administration of the questionnaires was a problem. In Australia, the school year starts in late January/early February and usually ends in December, whereas the school year in Indonesia starts in July and ends the following June. Before administering the questionnaires, the researcher

made sure that students in both countries had completed at least a term (or three months) of schooling during which time they could settle into their new class, establish a stable learning environment and form their attitudes to science.

6. Owing to the time factor and the logistics involved, the researcher could not collect or obtain information about variables that could influence conclusions from the surveys. For example, information related to socioeconomic background, achievement, school environment, the quality of science laboratories, teaching methods used and students' religious backgrounds in Australia and Indonesia were not collected and taken into account in the study.

7. Because the scope of this study was already quite large, it was not possible also to include some of the qualitative data-collection methods that have proved highly valuable in other learning environment studies (Tobin & Fraser, 1998). This is acknowledged as an important limitation of my study, and the inclusion of qualitative methods in future research is strongly recommended. In particular, using qualitative methods is likely to have been illuminating in attempting to explain the interesting between-genders and between-country differences (see Section 4.3) found through the use of quantitative survey methods.

5.5 DISTINCTIVENESS AND CONTRIBUTIONS OF THE STUDY

The present study is distinctive in that it is the first cross-national study of classroom learning environments involving Indonesia. There has been a limited number of previous studies of classroom environment in Indonesia (Margianti, Fraser & Aldridge, 2002; Soerjaningsih, Fraser, & Aldridge, 2001), but these studies were not cross-national. For example, an important contribution of the study was to translate, validate and make available to researchers and teachers widely-applicable questionnaires to assess classroom environment and student attitudes to science.

This study has a number of practical implications. First, questionnaires which assess learning environments and attitudes to science were carefully translated into the Indonesian language and validated using a large sample. These questionnaires are quite versatile and are likely to prove useful to researchers and teachers in Indonesia for a wide variety of applications in a wide variety of contexts. Second, the relatively strong, consistent and positive associations found between several science attitude scales and classroom environment scales in both countries once again reminds educators of how student attitudes to science can be enhanced by creating positive classroom learning environments. Third, the finding that Indonesian students perceive their classroom environments as less task oriented and equitable than do Australian students suggests desirable areas for change in Indonesian classrooms.

5.6 SUGGESTIONS FOR FUTURE RESEARCH

The *What Is Happening In This Class?* (WIHIC) questionnaire has been cross-validated in this study and has been found to be a valid, versatile, parsimonious and economical instrument that could be used with confidence in Indonesia. Also, the instrument could be employed to measure the learning environment of other disciplines besides science. Thus, in searching for the set of conditions that could contribute to academic excellence, perhaps it would be useful to use the WIHIC questionnaire to assess the psychosocial classroom environments of different subjects and for each level.

Now that the WIHIC questionnaire can be used with confidence in classroom environment research in Indonesia, the range of its potential future applications includes various academic subjects at different grade levels at the secondary school level. Also, based on the applications of classroom environment instruments from past research (Fraser, 1998a), the WIHIC could be used to evaluate educational innovations (e.g. new curricula and introduction of information technology), to investigate other independent variables (e.g. the social characteristics of classes or pupils) that influence classroom environment, and in action research aimed at improving classroom environments.

It would also be both worthwhile and interesting to investigate the effect of culture on students' perceptions of classroom environment and students' attitudes to science. A questionnaire such as the *Cultural Learning Environment Questionnaire* (CLEQ) (Fisher & Waldrip, 1997) or the *Scientific Orientation Test* (S.OR.T) (Meyer, 1995) could be used as these questionnaires are 'culturally sensitive'.

Future research should incorporate structured interviews and other qualitative data-collection techniques as suggested by Fraser and Tobin (1991) (see also Tobin & Fraser, 1998). The use of ethnographic procedures would not only complement, but also enhance, the wealth of quantitative data. Qualitative methods would serve as checks on the validity of the questionnaire responses and help in explaining relationships found with quantitative information. Besides these two benefits, qualitative methods enable more meaningful conclusions to be drawn from the findings obtained by quantitative methods. The use of the two-pronged approach (the combination of quantitative with qualitative methods) in future research is likely to enhance insights from the research.

Comparative studies that include cross-cultural elements provide a wealth of information regarding education not only in another country, but also in one's own country. Comparisons between Australia and other countries could identify interesting factors that might be beneficial not only to the education system of Australia, but also to the educational system of the other country involved in the cross-national/cultural study. Such studies are likely to be useful to teachers wishing to accommodate the multicultural nature of classrooms. The findings could help researchers to understand how the nature of learning environments might affect Australian students from different backgrounds and cultures.

The present investigation opens the way for studies that explore similarities and differences between learning environments that immigrants to Australia experienced in their old country and those that they are likely to experience in Australia. Such research could involve the impact of such a transition and explore ways in which the learning environment in Australia can be adapted to make these transitions smoother.

Future studies that explore cultural and social factors that influence the learning environment could lead to the investigation of how Westernised education, implanted in non-Western countries, might hinder the culture and tradition of that country. Such studies could explore ways in which science education and the learning environment could be made more culturally sensitive.

5.7 CONCLUDING REMARKS

It is hoped that the present study will make an important contribution to the booming field of learning environment research at the beginning of this 21st century. The research findings of this study should complement those of some other recent learning environment studies in the Southeast Asian region (Aldridge & Fraser, 2000; Goh and Khine (in press); Lee & Fraser, 2002; Margianti, Fraser & Aldridge, 2002; Soerjaningsih, Fraser & Aldridge, 2002). By combining the research findings of earlier and recent studies with my results, hopefully, it will be possible to get a good picture of the state of the learning environment in the Southeast Asian region. This would help to reinforce the educational links that Australia has already established with its northern neighbours.

Surprisingly, in spite of several key differences (culture, language and religion) that exist between Australia and Indonesia, students' perceptions to their classroom environment and students' attitudes to science are reasonably similar. Similarly, the differences that emerged in the results of the statistical analyses relating to the responses of male and female students in both Australia and Indonesia were also minimal.

Last, but not least, the researcher hopes that the present study could be used by science teachers, both in Australia and in Indonesia, to guide improvements in their classroom environments in order to enhance their students' attitude to science.

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APPENDIX A

English Version of the

What is Happening in this Class? (WIHIC) Questionnaire

What is Happening in this Class?

Directions for Students

These questionnaires contain statements about practices which could take place in this class. You will be asked how often each practice takes place.

There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Think about how well each statement describes what this class is like for you.

Draw a circle around

1	if the practice takes place	**Almost Never**
2	if the practice takes place	**Seldom**
3	if the practice takes place	**Sometimes**
4	if the practice takes place	**Often**
5	if the practice takes place	**Almost Always**

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

Practice Example

Suppose you were given the statement "I choose my partners for group discussion." You would need to decide whether you choose your partners 'Almost always', 'Often', 'Sometimes', 'Seldom' or 'Almost never'. If you selected 'Often' then you would circle the number 2 on your questionnaire.

SC		Almost Never	Seldom	Some-times	Often	Almost Always
1.	I make friendships among students in this class.	1	2	3	4	5
2.	I know other students in this class.	1	2	3	4	5
3.	I do favours for members of this class	1	2	3	4	5
4.	I am friendly to members of this class.	1	2	3	4	5
5.	Members of the class are my friends.	1	2	3	4	5
6.	I work well with other class members.	1	2	3	4	5
7.	I help other class members who are having trouble with their work.	1	2	3	4	5
8.	Students in this class like me.	1	2	3	4	5
9.	In this class, I get help from other students.	1	2	3	4	5
10.	Students help me with my homework	1	2	3	4	5
TS		**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
11.	The teacher takes a personal interest in me.	1	2	3	4	5
12.	The teacher goes out of his/her way to help me.	1	2	3	4	5
13.	The teacher considers my feelings.	1	2	3	4	5
14.	The teacher helps me when I have trouble with the work.	1	2	3	4	5
15.	The teacher talks with me.	1	2	3	4	5
16.	The teacher is interested in my problems.	1	2	3	4	5
17.	The teacher moves about the class to talk with me.	1	2	3	4	5
18.	It is alright for me to tell the teacher that I do not understand	1	2	3	4	5
19.	The teacher's questions help me to understand.	1	2	3	4	5
20.	It is alright with the teacher if I am slower than other students in the class	1	2	3	4	5
IN		**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
21.	I discuss ideas in class.	1	2	3	4	5
22.	I give my opinions during class discussions.	1	2	3	4	5
23.	The teacher asks me questions.	1	2	3	4	5
24.	My ideas and suggestions are used during classroom discussions.	1	2	3	4	5
25.	I ask the teacher questions.	1	2	3	4	5
26.	I explain my ideas to other students.	1	2	3	4	5
27.	Students discuss with me how to go about solving problems.	1	2	3	4	5
28	When starting a new topic, I discuss what I already know about it.	1	2	3	4	5
29.	I am asked to explain how I solve problems.	1	2	3	4	5
30	I discuss different answers to questions.	1	2	3	4	5

AI		Almost Never	Seldom	Some-times	Often	Almost Always
31.	I have a say in how their class time is used.	1	2	3	4	5
32.	I have a say in deciding what activities they do.	1	2	3	4	5
33.	I have a say in deciding how their learning is assessed.	1	2	3	4	5
34.	I am told how to do my work.	1	2	3	4	5
35.	The teacher decides when I am to be tested.	1	2	3	4	5
36.	The teacher decides how much movement and talk students are allowed.	1	2	3	4	5
37.	The teacher decides when the class moves on to a new topic.	1	2	3	4	5
38.	I am given a choice of topics for assignments.	1	2	3	4	5
39.	I am given a choice in which investigations I do.	1	2	3	4	5
40.	I work at my own pace.	1	2	3	4	5
IV		Almost Never	Seldom	Some-times	Often	Almost Always
41.	I draw conclusions from investigations.	1	2	3	4	5
42.	I carry out investigations to test my ideas.	1	2	3	4	5
43.	I am asked to think about the evidence for statements.	1	2	3	4	5
44.	I carry out investigations to answer questions coming from discussions.	1	2	3	4	5
45.	I explain the meaning of statements, diagrams and graphs.	1	2	3	4	5
46.	I carry out investigations to answer questions which puzzle me.	1	2	3	4	5
47.	I solve problems by obtaining information from the library.	1	2	3	4	5
48.	I carry out investigations to answer the teacher's questions.	1	2	3	4	5
49.	I find out answers to questions by doing investigations.	1	2	3	4	5
50	I solve problems by using information obtained from my own investigations.	1	2	3	4	5
TO		Almost Never	Seldom	Some-times	Often	Almost Always
51.	I know what has to be done in this class	1	2	3	4	5
52.	Getting a certain amount of work done is important to me.	1	2	3	4	5
53.	I do as much as I set out to do.	1	2	3	4	5
54.	Class assignments are clear so I know what I have to do.					
55.	I know the goals for this class.	1	2	3	4	5
56.	I am ready to start this class on time.	1	2	3	4	5
57.	I know what I am trying to accomplish in this class.	1	2	3	4	5
58.	I pay attention during this class.	1	2	3	4	5
59.	I try to understand the work in this class.	1	2	3	4	5
60.	I know how much work I have to do.	1	2	3	4	5

CO		Almost Never	Seldom	Some-times	Often	Almost Always
61.	I cooperate with other students when doing assignment work.	1	2	3	4	5
62.	I share my books and resources with other students when doing assignments.	1	2	3	4	5
63.	When I work in groups in this class, there is teamwork.	1	2	3	4	5
64.	I work with other students on projects in this class.	1	2	3	4	5
65.	I learn from other students in this class.	1	2	3	4	5
66.	Students work with each other in this class.	1	2	3	4	5
67.	I work with other students in this class.	1	2	3	4	5
68.	I cooperate with other students on class activities.	1	2	3	4	5
69.	Students work with me to achieve class goals.	1	2	3	4	5
70.	I work in groups in this class.	1	2	3	4	5
E		**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
71.	The teacher gives as much attention to my questions as to other students' questions.	1	2	3	4	5
72.	I get to use the equipment as much as other students.	1	2	3	4	5
73.	I get the same amount of help from the teacher as do other students.	1	2	3	4	5
74.	I have the same amount of say in this class as other students.	1	2	3	4	5
75.	I am treated the same as other students in this class.	1	2	3	4	5
76.	I receive the same encouragement from the teacher as other students do.	1	2	3	4	5
77.	I get the same opportunity to contribute to class discussions as other students.	1	2	3	4	5
78.	I am asked the same number of questions as other students.	1	2	3	4	5
79.	My work receives as much praise as other students' work.	1	2	3	4	5
80.	I get the same opportunity to answer questions as other students.	1	2	3	4	5

APPENDIX B

Indonesian Version of the

What is Happening in this Class? (WIHIC) Questionnaire

APPENDIX C

English Version of

Test of Science Related Attitudes (TOSRA)

TEST OF SCIENCE-RELATED ATTITUDE
(TOSRA)

Directions

1. The test contains a number of statements about science. You will be asked what you yourself thing about these statements. There are no "right" or "wrong" answers. Your opinion is what is wanted.

2. For each statement, draw a circle around:

   - if you STRONGLY AGREE with the statement;
   - if you AGREE with this statement;
   - if you are NOT SURE;
   - if you DISAGREE with the statement;
   - if you STRONGLY DISAGREE with the statement.

3. If you change your mind about an answer, cross it out and circle another one.

4. Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1.	Money spent on science is well worth spending.	1	2	3	4	5
2.	Scientists usually like to go to their laboratories when they have a day off.	1	2	3	4	5
3.	I would prefer to find out why something happens by doing an experiment than by being told.	1	2	3	4	5
4.	I enjoy reading about things that disagree with my previous ideas.	1	2	3	4	5
5.	Science lessons are fun.	1	2	3	4	5
6.	I would like to belong to a science club.	1	2	3	4	5
7.	I would dislike being a scientist after I leave school.	1	2	3	4	5
8.	Science is man's worst enemy.	1	2	3	4	5
9.	Scientists are about as fit and healthy as other people.	1	2	3	4	5
10.	Doing experiments is not as good as finding out information from teachers.	1	2	3	4	5
		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
11.	I dislike repeating experiments to check that I get the same results.	1	2	3	4	5
12.	I dislike science lessons.	1	2	3	4	5
13.	I get bored when watching science programs on TV at home.	1	2	3	4	5
14.	When I leave school, I would like to work with people who make discoveries in science.	1	2	3	4	5
15.	Public money spent on science in the last few years has been used wisely.	1	2	3	4	5
16.	Scientists do not have enough time to spend with their families.	1	2	3	4	5
17.	I would prefer to do experiments than to read about them.	1	2	3	4	5
18.	I am curious about the world in which we live.	1	2	3	4	5
19.	School should have more science lessons each week.	1	2	3	4	5
20.	I would like to be given a science book or a piece of scientific equipment as a present.	1	2	3	4	5

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
21.	I would dislike a job in a science laboratory after I leave school.	1	2	3	4	5
22.	Scientific discoveries are doing more harm than good.	1	2	3	4	5
23.	Scientists like sport as much as other people do.	1	2	3	4	5
24.	I would rather agree with other people than do experiments to find out for myself.	1	2	3	4	5
25.	Finding out about new things is unimportant.	1	2	3	4	5
26.	Science lessons bore me.	1	2	3	4	5
27.	I dislike reading books about science during my holidays.	1	2	3	4	5
28.	Working in a science laboratory would be an interesting way to earn a living.	1	2	3	4	5
29.	The government should spend more money on scientific research.	1	2	3	4	5
30.	Scientists are less friendly than other people.	1	2	3	4	5
		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
31.	I would prefer to do my own experiments than to find out information from a teacher.	1	2	3	4	5
32.	I like to listen to people whose opinions are different from mine.	1	2	3	4	5
33.	Science is one of the most interesting school subjects.	1	2	3	4	5
34.	I would like to do science experiments at home.	1	2	3	4	5
35.	A career in science would be dull and boring.	1	2	3	4	5
36.	Too many laboratories are being built at the expense of the rest of education.	1	2	3	4	5
37.	Scientists can have a normal family life.	1	2	3	4	5
38.	I would rather find out about things by asking an expert than by doing an experiment.	1	2	3	4	5
39.	I find it boring to hear about new ideas.	1	2	3	4	5
40.	Science lessons are a waste of time.	1	2	3	4	5

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
41. Talking to friends about science after school would be boring.	1	2	3	4	5
42. I would like to teach science when I leave school.	1	2	3	4	5
43. Science helps to make life better.	1	2	3	4	5
44. Scientists do not care about their working conditions.	1	2	3	4	5
45. I would rather solve a problem by doing an experiment than be told the answer.	1	2	3	4	5
46. In science experiments, I like to use new methods which I have not used before.	1	2	3	4	5
47. I really enjoy going to science lessons.	1	2	3	4	5
48. I would enjoy having a job in a science laboratory during my school holidays	1	2	3	4	5
49. A job as a scientist would be boring.	1	2	3	4	5
50. This country is spending too much money on science.	1	2	3	4	5
	Strongly Agree	**Agree**	**Not Sure**	**Disagree**	**Strongly Disagree**
51. Scientists are just as interested in art and music as other people are.	1	2	3	4	5
52. It is better to ask the teacher the answer than to find it out by doing experiments.	1	2	3	4	5
53. I am unwilling to change my ideas when evidence shows that the ideas are poor.	1	2	3	4	5
54. The material covered in science lessons is uninteresting.	1	2	3	4	5
55. Listening to talk about science on the radio would be boring	1	2	3	4	5
56. A job as a scientist would be interesting.	1	2	3	4	5
57. Science can help to make the world a better place in future.	1	2	3	4	5
58. Few scientists are happily married.	1	2	3	4	5
59. I would prefer to do an experiment on a topic than to read about it in a science magazine.	1	2	3	4	5
60. In science experiments, I report unexpected results as well as expected ones.	1	2	3	4	5

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
61.	I look forward to science lessons.	1	2	3	4	5
62.	I would enjoy visiting a science museum at the weekend.	1	2	3	4	5
63.	I would dislike becoming a scientist because it needs too much education.	1	2	3	4	5
64.	Money used on scientific projects is wasted.	1	2	3	4	5
65.	If you met a scientist, he would probably look like anyone else you might meet.	1	2	3	4	5
66.	It is better to be told scientific facts than to find them out from experiments.	1	2	3	4	5
67.	I dislike listening to other people's opinions.	1	2	3	4	5
68.	I would enjoy school more if there were no science lessons.	1	2	3	4	5
69.	I dislike reading newspaper articles about science.	1	2	3	4	5
70.	I would like to be a scientist when I leave school.	1	2	3	4	5

APPENDIX D

Indonesian Version of the

Test of Science Related Attitudes (TOSRA)

APPENDIX E

Letter from the Director of Catholic Education

Of Sydney, New South Wales, Australia

APPENDIX F

Letter from the Director of Catholic Education

Of Perth, Western Australia, Australia