Science and Mathematics Education Centre

Associations Between Teachers' Interpersonal Behaviour, Classroom Learning Environment and Students' Outcomes

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DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this thesis contain no material previously published by any other person except where due acknowledgment has been made.

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ABSTRACT

I investigated associations between teachers' interpersonal behavior, the classroom learning environment and students' outcomes. The Questionnaire on Teacher Interaction (QTI), What Is Happening In this Class? (WIHIC), and Test Of Science-Related Attitudes (TOSRA) were used with a sample of 785 students from 75 classes in five high schools in New York. Results from the New York State Regents examination taken in June were collected for 603 students in 37 classes as a measure of achievement.

Data analyses supported the factor structure, internal consistency reliability and discriminant validity of the WIHIC questionnaire and the attitude scales from TOSRA, as well as WIHIC scales' ability to differentiate between classrooms. Data analyses also supported the internal consistency reliability of the QTI and its ability to differentiate between classrooms. Also, the circumplex nature of the QTI was supported by analyzing its pattern of scale intercorrelations. Overall, the learning environment instruments (QTI and WIHIC) and attitude instrument (TOSRA) were found to be valid and reliable when used with high school science students in New York.

Simple correlation and multiple regression analyses revealed positive associations between the learning environment and students' attitudes. All seven WIHIC scales were statistically significantly correlated with attitudes to science. Overall Teacher Support was the strongest independent predictor of student attitudes to science. Positive but weak associations were also found between learning environment and achievement (especially Task Orientation, Equity, Student Cohesiveness and Involvement). Also Equity was positively and independently associated with achievement.

Associations were found between teachers' interpersonal behavior and attitudes (Adoption of Scientific Attitudes and Enjoyment of Science Lessons) and achievement. With the student as the unit of analysis, the Adoption of Scientific Attitudes scale was significantly correlated with all the QTI scales except Strict. With the class as the unit of analysis, all the QTI scales were significantly correlated

with Adoption. Leadership and Understanding were the only independent predictors of Adoption. Leadership, Understanding, Helping/Friendly, Uncertain, and Dissatisfied scales were positively and independently associated with Enjoyment of Science Lessons with the student as unit of analysis whereas, with class as unit of analysis, only Uncertain was positively and independently associated with Enjoyment. Associations were mostly in the expected directions, but with a few exceptions (e.g. Uncertain behavior was negatively related to student achievement).

Commonality analyses were undertaken to investigate the unique and common contributions of the WIHIC and the QTI scales to the variance in student outcomes. The benefit of using both instruments together to predict Enjoyment, but not Adoption, was supported by the findings. Therefore, it is worthwhile to include both the WIHIC and QTI in the same study of students' enjoyment of science. For achievement, neither the WIHIC nor the QTI accounted for much unique or common variance.

A subsample of 40 students was interviewed using questions pertaining to each scale of the QTI, WIHIC and TOSRA in order to check the construct validity of the questionnaires. Findings from these interviews reinforced the validity of the WIHIC, QTI and TOSRA for use with the sample of high school biology students in New York because interview findings were mostly consistent with the means obtained for each scale.

By providing validation data for the WIHIC, QTI and TOSRA, this study has provided New York teachers with instruments that can easily be used to assess associations between learning environment, teachers' interpersonal behavior and student outcomes. Also, this research has practical implications that suggest that teachers wishing to improve their students' attitudes and achievements should place greater emphasis on Leadership, Helping/Friendly, Understanding, and Student Responsibility/Freedom in their classroom. Also Student Cohesiveness, Teacher Support, Involvement, Cooperation and Equity should be emphasized.

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Chapter 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Teachers of the subject called Living Environment and teachers in general use different methods and approaches in teaching. These different methods form an important part of the learning environment, which different students perceive differently, and so experience different levels of success or mastery of topics taught. Typically, teachers concentrate almost exclusively on the assessment of academic achievement, and devote little attention to factors which might be related to the students' academic achievement. The quality of life lived in the classroom determines many of the things that we hope for from education and it is an important influence on the achievement measures to which so much interest is directed (Fraser, 2001). Students spend a long time in school: about 7,000 hours by the end of their primary-school education (Jackson, 1968); and 15,000 hours by the completion of secondary education (Rutter, Maughan, Mortimore, Ouston, & Smith, 1979). By the time graduates complete their university courses, they have spent nearly 20,000 hours in educational institutions (Fraser, 2001). Because of this, students' perception of their learning environment and teachers' interpersonal behavior, as well as students' attitudes and achievement, become important aspects to be researched. All of these variables are not traditionally part of teachers' evaluation processes. At the classroom level, teachers' behaviors while interacting with students have been found to influence students' like or dislike for learning a subject (Goh, Young & Fraser, 1995; Wubbels, Brekelmans & Hermans, 1987; Wubbels & Levy, 1993)

Many past studies of student achievement have revealed that cooperative learning is more successful than either competitive or individualistic learning. The generally positive effect of cooperative learning approaches on student achievement is illustrated by the findings of a comprehensive meta-analysis involving 122 studies (Johnson, Muruyama, Johnson, Nelson & Skon, 1981). However, this synthesis was not totally conclusive and generalizable as a large proportion of these studies involved

group outcomes rather than students' individual outcomes, which are so important in primary and secondary schooling (Fraser, 2000).

Owens and Straton (1980) investigated students' preferences for different types of classroom environments. Girls were found to prefer cooperation more than boys, but boys preferred both competition and individualization more than girls. Byrne, Hattie and Fraser (1986) found that boys preferred friction, competitiveness and differentiation more than girls, whereas girls preferred teacher structure, personalization and participation more than boys. Several studies have revealed that girls generally hold perceptions of their classroom environments that are somewhat more favorable than the perceptions of males in the same classes (Fisher, Fraser, & Rickards, 1997; Henderson, Fisher & Fraser, 1995).

This study investigated the learning environment in order to get a better understanding of how different students perceive teachers' interpersonal relationships in the classroom. The study investigated how these perceptions affect the student learning outcomes of achievement and attitudes. The rationale is that an investigation of science classroom learning environment in terms of teachers' interpersonal behavior, learning environment and students' outcomes has the potential to provide an opportunity to encourage researchers and science teachers to assess their classroom learning environments and so improve the quality of their teaching and professional life (Wititsiri, 2007). Often, students will make comments such as "I like Mr A's class, he is my best teacher". Many times, this student's achievement score in this particular class is high. This raises questions about whether there is a relationship between students' cognitive achievement, attitudes to a subject and the classroom learning environment. Rickards (1998) found a relationship between student cognitive achievement, attitude to a subject and learning environment in classrooms in Australia. This again points to the fact that the nature of teacher-student interactions and learning environment can contribute to student outcomes.

1.2 THEORETICAL FRAMEWORK

The foundation for classroom environment research was laid more than 70 years ago, according to Henderson, Fisher and Fraser (1995), with the work of Lewin (1936) and Murray (1938). Lewin (1936) recognized that both the environment and its interaction with personal characteristics of the individual determine human behavior. The Lewinian formula B=f (P, E) stressed the need for new research strategies in which behavior (B) is considered to be a function of the person (P) and the environment (E). Murray (1938) was the first to follow Lewin's approach, which led to his proposal of the needs-press model. In Murray's model, personal need refers to the individual's personality characteristics which motivate the person to move in the direction of certain goals. Environmental press provides external situations which either support or frustrate the expression of internalized needs. An integral part of my study was to investigate associations between students' perceptions of the learning environment and the outcomes of achievement and attitudes.

Walberg and Moos initiated the field of learning environment research in the 1960s. Moos developed numerous social climate scales which were used in hospitals and correctional institutions (Moos, 1981). Later this led to the development of the Classroom Environment Scale (CES) (Moos & Trickett, 1974). Moos proposed three categories for classifying the diverse characteristics of any human environment: Relationship dimensions which assess personal relationships such as how the people in the environment support and help each other; Personal Development dimensions which deal with personal growth and self-enhancement; and System Maintenance and System Change dimensions which involve the extent to which the environment is orderly, clear in expectations, maintains control, and is responsive to change.

Walberg developed the Learning Environment Inventory (LEI) for research associated with the Harvard Project Physics (Walberg & Anderson, 1968). This study, which involved the evaluation of the learning environments of physics classes, showed that students could make valid summary judgments about their classrooms. The LEI was validated with 1,083 students from 149 classes (Fraser, Anderson & Walberg, 1982).

Having recognized the importance of the environment (building on the work of Lewin, 1936), Walberg proposed a model of educational productivity in which learning is a function of age, ability and motivation, the quality and quantity of instruction, and the social-psychological environments of the class and the home as well as the peer group outside the classroom and mass media (Walberg, 1981).

Ever since then, researchers have developed numerous questionnaires to measure perceptions of different dimensions in learning environment (Fraser, 1998a). The use of learners' perceptions of classroom environment as predictor variables has established consistent relationships between the nature of classroom environment and the learner's cognitive and affective outcomes (Fraser, 1998b). For over 40 years, Moos' work has influenced the development and use of questionnaires to assess the qualities of the classroom learning environment from the perspective of the student. Paige (1979) used the CLES and LEI to reveal that individual modernity among Indonesian students was enhanced in classrooms perceived as having greater task orientation, competition and difficulty and less order and organization, while achievement was enhanced in classrooms higher in speed and lower in order and organization.

A variety of economical, valid and widely-applicable questionnaires have been developed and used for assessing students' perception of classroom environment, including the Questionnaire on Teacher Interaction (QTI) which was developed by Wubbels, Cretons, and Hooymayers (1985); Science Laboratory Environment Inventory (SLEI) (McRobbie & Fraser, 1993); Constructivist Learning Environment Survey (CLES) developed by Taylor, Fraser and Fisher (1997); and the What Is Happening In this Class? (WIHIC) developed by Fraser, Fisher and McRobbie (1996).

In the 1980s, much more attention was paid to research on interpersonal teacher behavior than before. In a study in the Netherlands, Wubbels, Creton and Hooymayers (1985) focused on the teacher variable for improving the learning environment, and developed a model to map teacher interpersonal behaviors. It was based on the model for interpersonal behavior of Leary (1957). The Leary model, with its two dimensions of influence and proximity, has been extensively applied in

clinical psychology and psycho-therapeutic settings and has proven to be a rather complete model for describing interpersonal behavior (Fao, 1961). However, an interpersonal checklist based on this model was found not to be suitable for measuring teacher interpersonal behavior. Therefore, Wubbels et al. (1985) adapted the Leary model and developed the model for interpersonal teacher behavior. They mapped the behavior of teachers with a proximity dimension (Cooperation–C, Opposition–O) and an influence dimension (Dominance–D, Submission–S). These dimensions were represented in a coordinate system divided into eight equal sections each named to represent the following typical behaviors of the teacher: Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing and Strict. Thus the QTI was developed to assess teachers' interpersonal behavior. The QTI has been shown to be valid, reliable and useful when used in the Netherlands with 1,105 students and 66 teachers (Wubbels & Levy, 1993), in the USA with 1,606 students and 66 teachers (Wubbels & Levy, 1991), and in Australia with 489 students in 28 classes (Fisher, Henderson & Fraser, 1995). The QTI was used in my study to assess teachers' interpersonal behavior.

The What Is Happening In this Class? (WIHIC) questionnaire brings parsimony to the field of learning environments by combining modified versions of the most salient scales from a wide range of existing questionnaires with additional scales. The WIHIC (Fraser, Fisher & McRobbie, 1996) incorporates scales that have been shown in previous studies to be important predictors of outcomes and also reflects recent cognitive views of science learning (Kim, Fisher, & Fraser 2000). The WIHIC has been found reliable, valid and useful in many past studies in different countries and in different contexts, including a cross-national study of science classrooms with 1,879 grade 7–9 students from 50 classes in Taiwan and Australia (Aldridge, Fraser & Huang, 1999), in Indonesia with 2,498 computing students in 50 classes (Margianti, Fraser & Aldridge, 2004), and in Korea with 543 students in 12 schools (Kim, Fisher & Fraser, 2000). The 56-item 7-scale version of the WIHIC was used in my study. The seven scales are Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity.

Currently, the promotion of favorable science-related attitudes is considered in many countries to be one of the important aims of science education. The Test Of Science-

Related Attitudes (TOSRA) was designed to measure seven distinct science-related attitudes among secondary school students (Fraser, 1981): 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. Since its development, the TOSRA has been further cross-validated with several samples in different studies from different countries, including with 1,161 students (594 students from 18 classes in Indonesia and 567 students from 18 classes in Australia) by Fraser, Aldridge and Adolphe (in press), with 644 chemistry students from 35 classes in 23 schools in Brunei Darussalam (Riah & Fraser, 1998), and with 1,188 Form 5 students from 54 classes also in Brunei (Khine & Fisher, 2002). Wong and Fraser (1996) used a modified version of TOSRA, called the Questionnaire on Chemistry-Related Attitudes (QOCRA), to assess students' attitudes towards chemistry in laboratory classrooms in Singapore with a sample of 1,592 final year (i.e. tenth grade) secondary school chemistry students in 56 intact classes in 28 schools. Two of the TOSRA scales, Adoption of Scientific Attitudes and Enjoyment of Science Lessons, were used in my study to assess students' attitudes to science.

Lee, Fisher and Fraser (2003), in their study of teacher-student interactions in Korean high school science classrooms, found that students' attitude scores were higher in classrooms in which students perceived greater Leadership, Helping/Friendly, and Understanding behaviors in their teachers. Kim, Fisher and Fraser (2000) studied classroom learning environments and teacher behaviors in 12 Korean schools and found positive relationships between classroom environment and interpersonal teacher behavior and students' attitudinal outcomes. In a study of associations between learning environments in mathematics classrooms and students' attitudes, it was found that students developed more positive attitudes towards mathematics in classes where the teacher was perceived to be highly supportive and equitable and to involve students in investigations (Rawnsley & Fisher, 1998). Koul and Fisher (2005) investigated science classroom learning environments in India and found that the WIHIC scales of Investigation, Task Orientation and Equity were positively and significantly related to students' attitudes. Overall, previous studies indicated that teachers' interactions with their students are important aspects of the classroom

learning environment that are related consistently to student outcomes, both cognitive and affective (Wubbels & Levy, 1991).

My study examined associations between teachers' interpersonal behavior, learning environment and students' outcomes in high school biology classrooms. To do this, I used the 56-item 7-scale version of the WIHIC (Fraser, Fisher, & McRobbie, 1996), the 48-item 8-scale version of the QTI, and two scales of the TOSRA (Enjoyment of Science Lessons and Adoption of Scientific Attitudes) to assess students' science attitudes. The present study extended and built upon the work in learning environment research started more than 40 years ago.

1.3 AIMS AND OBJECTIVES

The study was conducted with high school students in biology classes during their regular class time. For the first time, a combination of the QTI, WIHIC and TOSRA was administered to students in New York. The objectives of the study were to:

1. Cross-validate the QTI, WIHIC, and TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with a New York sample.
2. Investigate associations between the classroom learning environment and students':
    a. Science achievement
    b. Attitudes to science
3. Investigate associations between teacher interpersonal behavior and students':
    a. Science achievement
    b. Attitudes to science.
4. Investigate the magnitude of the unique and common contributions of the WIHIC and QTI in explaining variance in students':
    a. Science achievement
    b. Attitudes to science.

1.4 SIGNIFICANCE OF THE STUDY

The study is important for my own role as a teacher because, when I find out about associations between teachers' interpersonal behavior, learning environment and the students' outcomes of achievement and attitudes, I will then be able to create a more positive classroom learning environment which will foster improvement in students' academic achievement and attitude.

To my institution, my findings about associations between learning environment and students' outcomes could help in planning staff development activities geared towards assisting science teachers to develop a more positive learning environment, in order to maximize student learning outcomes. Teachers might consider strategies or design activities in a classroom that could enhance outcomes such as achievement and attitudes. Therefore, this study is likely to provide worthwhile practical implications about how to improve students' outcomes by creating classroom environments that emphasize dimensions found to be specifically related to improved outcomes.

Although past studies have examined associations between student attitudes and achievement and student perceptions of the learning environment in classes in a number of countries (Fraser, 1998b), this study is distinctive in that it is one of the first to investigate these associations specifically in classrooms in New York. This provides a contribution to the field of learning environment.

This study is likely to provide further validation information for the WIHIC and QTI when used specifically in biology classrooms in New York. Therefore, researchers will be able to use these questionnaires with confidence in biology classrooms in New York in the future.

1.5 LIMITATIONS OF THE STUDY

The help of other teachers was solicited in collecting some of the data. Some of these teachers did not follow all of the requested procedures for data collection, which rendered unusable some of the data initially collected for the study. A lot of time was wasted in going back and repeating the process and, in some cases, repeating data

collection was not possible the second time. Some of the teachers were not totally committed to cooperating but did not say so at the outset.

Some school district administrators refused access to their schools for conducting the research. This limited the number of schools included to only five. Although these five schools appear to have students who are representative of all high school biology students, some of the schools have a very large number of biology classes.

The limitations of time and the nature of my study also restricted the scope and sample size. One of the aims of this study was to investigate associations between classroom learning environment and students' outcomes of achievement and attitudes, and between teachers' interpersonal behavior and students' outcomes. The results of the Regents examination taken just before the end of the school were used as a measure of students' achievement in biology. For the achievement scores to be useful, and matched with students' current classroom learning environment scores, ideally they would have been collected within the same school year. Larger samples would have been easily collected if the Regents examination had been taken after two years of studying Living Environment (Biology). It would have been more desirable to have achieved a larger and more representative sample so that my findings would have had better generalizability.

Another limitation is that any sample is always restricted, which affects the generalizabilty of results. Some students left a couple of questions blank which rendered those questionnaires useless. Over 30 students' questionnaires were discarded because of incompleteness. The readability of the questionnaire was another limiting factor because some students might have had difficulties reading the questionnaires.

The small scope of the qualitative component was also a limiting factor. Not all the students were interviewed as this was practically impossible.

1.6 OVERVIEW OF THE METHODOLOGY

Both qualitative and quantitative methods of data collection were used. Educational researchers interested in educational evaluation have advocated the merits of combining qualitative and quantitative methods within the same study (Cook & Reichardt, 1979). The approaches can be interwoven to provide more depth than would have been provided by using only one of the methods (Fraser & Tobin, 1991; Howe, 1988; Tobin & Fraser, 1998). This triangulation of qualitative and quantitative classroom environment data can enhance the validity of the findings because a range of methods, each with its strengths and weaknesses, is used (Spinner & Fraser, 2005). Triangulation can provide support for a finding by showing that independent data-collection methods agree or at least don't contradict each other (Miles & Huberman, 1984). Thus, it was decided that my study would include quantitative data collection (questionnaires) as the major method used and qualitative methods (interviews) as the minor method of data collection.

Including qualitative methods of data collection in this study served a number of purposes. The main purpose was to support the validity of the QTI and WIHIC by checking the consistency of questionnaire and interview data. Another reason was to obtain students' comments about any difficulties that they might have experienced in interpreting or understanding the items in the questionnaire.

For the quantitative part of the study, 785 students from 75 classes in five high schools in New York were involved. The 56-item 7-scale version of the WIHIC (Fraser, Fisher & McRobbie, 1996) and the 48-item 8-scale version of the QTI (Wubbels & Brekelmans, 1998; Wubbels & Levy, 1993) were used to collect data on students' perceptions of their learning environment and their teachers' interpersonal behavior. The Adoption of Scientific Attitudes and Enjoyment of Science Lessons scales from the Test Of Science-Related Attitudes (TOSRA; Fraser, 1981) were selected for assessing students' science attitudes. To assess achievement, the Living Environment (Biology) Regents score at the end of the academic year was used.

The qualitative component involved interviewing 40 students (20 males and 20 females). The scope of the qualitative component was relatively small compared with

the quantitative component. Responses to the QTI, WIHIC and TOSRA scales guided the selection of the sample of students for qualitative data collection. Qualitative and quantitative data were combined to provide more depth to the study than would have been possible by using only one of the methods (Fraser & Tobin, 1991; Howe, 1988; Tobin & Fraser, 1998).

Data analyses were undertaken using SPSS. Students' responses to the QTI, WIHIC and TOSRA were used. To examine the validity of the WIHIC and TOSRA, factor analyses, internal consistency reliability and discriminant validity for two units of analyses (class mean and individual students) were conducted. The QTI was analyzed similarly except for factor analyses and discriminant validity. These analyses were not undertaken for QTI scales because of the circumplex nature of the instrument. Also, a one-way ANOVA was undertaken for the QTI and the WIHIC to ascertain each scale's ability to differentiate between the perceptions of students in different classrooms.

This study investigated associations between: student outcomes of attitudes and achievement and teacher interpersonal behavior; and student outcomes of attitudes and achievement and classroom learning environment. Simple correlation coefficients were calculated between each scale of the WIHIC, QTI, TOSRA and achievement. Also multiple regression analyses, involving the whole set of scales in each environment instrument, were conducted to provide information about multivariate associations between each student outcome and a set of learning environment or interpersonal behavior scales. In addition, commonality analyses were conducted to examine the magnitude of the variance in student outcomes explained uniquely and jointly by interpersonal teacher behavior (QTI) and classroom learning environment (WIHIC) with the student as the unit of analysis.

Some previous studies of science classroom environment have involved using both the WIHIC and QTI questionnaires (Koul & Fisher 2005; Kim, Fisher, & Fraser 2000). However, such a study has never been conducted in science classrooms in New York.

1.7 OVERVIEW OF THE THESIS

This thesis consists of six chapters. Chapter 1 introduced the study by summarizing its background, theoretical framework, aims and objectives, significance, limitations and methodology.

Chapter 2 reviews some of the literature describing past research on learning environments, teacher interpersonal behavior and student attitudes. The development of learning environment instruments is described. A review of studies of associations between student outcomes and classroom environment, as well as review of literature from past studies using the Questionnaire on Teacher Interaction and the What Is Happening In this Class?, are also presented in this chapter.

Chapter 3 describes the methodology used in this study. Included are descriptions of the data-collection processes, the selected research methods, and procedures for data analysis and interpretation. In addition, difficulties encountered during data collection are described.

Chapter 4 reports results for my study's first research objective involving the cross-validation of the QTI, the WIHIC and the TOSRA when used with a New York sample. Factor analyses and discriminant validity also are reported for the WIHIC and TOSRA. As well, internal consistency reliability is reported for all three instruments. The ability to differentiate between classes (ANOVA) is reported for the QTI and the WIHIC scales. Validity data regarding the QTI were also obtained from the scale intercorrelation matrix. In addition, qualitative findings from interviews are reported in order to support the validity of the QTI and the WIHIC.

Chapter 5 reports associations between the learning environment and the student outcomes of attitudes and achievement. Analyses illuminate associations between: WIHIC scales and the student outcomes of achievement and attitude; and QTI scales and the student outcomes of achievement and attitude. A series of simple correlation and multiple regression analyses, using two units of analysis, was used to investigate the associations reported in this chapter. In addition, commonality analyses were conducted to examine the magnitude of the variance in student outcomes explained

uniquely and jointly by interpersonal teacher behavior (QTI) and classroom learning environment (WIHIC) with the student as the unit of analysis.

Finally, Chapter 6 summarizes results related to the research objectives. In particular, results concerning associations between teachers' interpersonal behavior, classroom learning environment and students' outcomes are recapitulated. Furthermore, interpretations of findings based on qualitative and quantitative data collection are discussed. This chapter also discusses implications, limitations and conclusions of this study, as well as suggestions for further research.

1.8 CHAPTER SUMMARY

This first chapter has outlined some background to the study, its theoretical framework, its aims and objectives, and its significance. A brief overview of the methodologies and the content of each chapter in this thesis were also presented. Some limitations of the study, which were introduced briefly in Chapter 1, are discussed in more detail in the final chapter of this thesis, together with its implications and conclusions and suggestions for further research.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

The major purpose of the present study was to investigate associations between teachers' interpersonal behavior, the classroom learning environment and students' outcomes. The review of literature related to this study is organized in this chapter under the following headings:

2.2 Introduction to Research on Learning Environments
2.3 Development of Learning Environment Questionnaires
2.4 What Is Happening In this Class? (WIHIC)
2.5 Questionnaire on Teacher Interaction (QTI)
2.6 Assessment of Students' Attitudes
2.7 Chapter Summary.

2.2 INTRODUCTION TO RESEARCH ON LEARNING ENVIRONMENTS

As mentioned earlier in Section 1.2, the foundation of learning environment research was laid more than 70 years ago by Kurt Lewin (1936). Lewin pointed out that human behavior (*B)* is a function of the interaction between the individual person (*P*) and the environment (*E)* as stated in his formula *B*=f *(P,E*). In other words, the environment and the personal characteristics of an individual determine human behavior.

Murray (1938) used Lewin's approach to propose a theory to describe an individual's personal needs and environmental press in a need-press model. This refers to the interaction between the person and the environment. The presses are the environmental factors beyond an individual's control that either enhance or inhibit an individual's achievement of personal needs and goals. Murray used the term 'alpha press' to describe the environment as viewed by an external observer and the term

'beta press' to describe the environment as perceived by members of that environment.

Stern, Stein and Bloom (1956) further developed Murray's need-press model by dividing beta press into 'private' beta press (the individual student's view of his or her class environment) and 'consensual' beta press (the view held by the entire class as a group). My study utilized both the private beta press and the consensual beta press of the students for the data collected through interviews and surveys.

Fraser (1998a) suggested that researchers, when designing classroom environment studies, must decide whether their data analyses will involve the private beta press, consensual beta press or both. Pace and Stern (1958) utilized and extended Murray's needs-press model to report on high-inference measures in educational learning environments. High inference measures, recorded during classroom observation, require an observer to make an inference about the teacher's behavior in terms of warmth, clarity and effectiveness in line with his or her direct observation and systematic coding of classroom communication and events. The problem with this is that outside observers rely on observations that are based on external experiences of the learning environment. Pace and Stern (1958) suggested that finding an association between the environmental press and a student's needs might be useful in predicting personal achievement. One aim of this study was to investigate associations between students' perceptions of their teachers' interpersonal behavior and their classroom learning environment and their outcomes of achievement and attitudes.

Using perceptual measures with students for assessing classroom environment relative to observations made by external observers has several advantages as highlighted by Fraser and Walberg (1991) and Fraser, Anderson and Walberg (1982):

- Because the class is described through the eyes of actual participants, some important data are picked up that could be missed by an external observer or simply considered unimportant.
- The participants within the classroom (teacher and students) are the best people for assessing the classroom environment.

- Students' observations are based on a longer time period than those of an outside observer.
- Perceptions of the whole class are gathered rather than those of only one or two observers.
- Students' perceptions are considered to be determinants of their classroom behavior and, even when these perceptions are inaccurate, they still explain students' behavior.
- Perceptual measures are able to account for more variance in student learning outcomes than directly observed variables.

Past reviews of research show progress in learning environment research involving students' perceptions of teachers' interpersonal behavior, learning environment and students' outcomes. Fisher, Fraser and Rickards (1997) and Henderson, Fisher and Fraser (1997) found that girls hold perceptions of their classroom learning environment that are somewhat more favorable than the perceptions of males in the same classroom. Lee, Fisher and Fraser (2003), in their study of teacher-student interactions in Korean high schools science classrooms, found that students' attitude scores were higher in classrooms where students perceived more positive teacher interpersonal behaviors. Kim, Fisher and Fraser (2000) studied classroom learning environment and teacher interpersonal behavior in 12 Korean schools and found positive relationships between classroom environment and interpersonal teacher behavior and students' attitudinal outcomes. Rawnsley and Fisher (1998) investigated the perceptions of ninth-grade mathematics students in South Australia and found that students develop more positive attitudes towards their mathematics in classrooms where they perceived their teacher's interpersonal behavior to be more positive. Koul and Fisher (2005) investigated science classroom learning environments in India and found that the WIHIC scales of Investigation, Task Orientation and Equity were positively and significantly related to students' attitudes. Aldridge, Fraser and Huang (1999) conducted a cross-national study of science classroom learning environment in Taiwan and Australia and found that Australian students perceived Teacher Support and Equity more favorably than did the Taiwanese students.

2.3 DEVELOPMENT OF LEARNING ENVIRONMENT QUESTIONNAIRES

This section describes several instruments that have been developed and used for assessing classroom learning environment. In line with Moos' (1974) scheme for classifying human environment, many instruments have been developed and used for learning environment research. The three types of dimensions according to Moos are Relationship Dimensions, Personal Development Dimensions and System Maintenance and System Change Dimensions. Relationship Dimensions identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support and help each other. Personal Development Dimensions assess personal growth and self-enhancement. System Maintenance and System Change Dimensions involve the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change.

Literature pertaining to the following classroom environment instruments is reviewed in Sections 2.3.1 to 2.3.13 below:

- Learning Environment Inventory (LEI)
- Classroom Environment Scale (CES)
- Individualised Classroom Environment Questionnaire (ICEQ)
- My Class Inventory (MCI)
- College and University Classroom Environment Inventory (CUCEI)
- Science Laboratory Environment Inventory (SLEI)
- Constructivist Learning Environment Survey (CLES)
- Geography Classroom Environment Inventory (GCEI)
- Computer Classroom Environment Inventory (CCEI)
- Cultural Learning Environment Questionnaire (CLEQ)
- Distance and Open Learning Environment Scale (DOLES)
- Socio-Cultural Environment Scale (SCES)
- Distance Education Learning Environment Survey (DELES).

Because the WIHIC and the QTI were used in my study, they are discussed in more detail in Sections 2.4 and 2.5, respectively.

2.3.1 Learning Environment Inventory (LEI)

The Learning Environment Inventory (LEI), as mentioned earlier, was developed in the 1960s as part of the research and evaluation activities of Harvard Project Physics (Fraser, Anderson, & Walberg, 1982; Walberg & Anderson, 1968). The final version contains a total of 105 statements, with seven items in each of the 15 scales. The 15 scales are Cohesiveness, Friction, Favoritism, Cliqueness, Satisfaction, Apathy, Speed, Difficulty, Competitiveness, Diversity, Formality, Material Environment, Goal Direction, Disorganization and Democracy. The four responses, which express the degree of agreement or disagreement, are Strongly Disagree, Disagree, Agree, and Strongly Agree. Some of the items are negatively worded. The LEI has been used to study associations between school classes, classroom expectation and classroom learning environment. However, the LEI has been found to be difficult to read and to take too long to answer for non-English-proficient students (Majeed, Fraser, & Aldridge, 2002).

2.3.2 Classroom Environment Scale (CES)

Prior to the development of the CES, Moos created questionnaires for assessing perceptions of numerous human environments, including psychiatric hospitals, prisons, university residences and work milieus (Moos, 1974). The original version of the CES contained 242 items made of 13 conceptual dimensions (Trickett & Moos, 1973; Moos & Trickett, 1974). The final version contains 9 scales with 10 items of True–False response format in each scale. The 9 scales are Involvement, Affiliation, Teacher Support, Task Orientation, Competition, Order and Organisation, Rule Clarity, Teacher Control, and Innovation. Sample items in the CES are: "Students daydream a lot in this class" (Involvement); "Students in this class get to know each other really well" (Affiliation) and "The teacher takes a personal interest in students" (Teacher Support). About half of the items are reverse scored. The CES has separate Actual and Preferred forms. The Actual form assesses students' perception of their actual learning environments and the Preferred form assesses the learning

environment that students would prefer. Published materials associated with the CES include a test manual, a questionnaire, an answer sheet and a transparent hand-scoring key.

2.3.3 Individualised Classroom Environment Questionnaire (ICEQ)

The ICEQ was developed to assess dimensions which distinguish individualized classrooms from conventional ones. The initial version of the ICEQ (Rentoul & Fraser, 1979) had five scales with 15 items per scale. The final version (Fraser, 1990) contains 50 items and the five scales of Personalization, Participation, Independence, Investigation, and Differentiation. The responses are based on a five-point frequency scale with the alternative responses of Almost Never, Seldom, Sometimes, Often, and Very Often. The scoring direction is reversed for about half of the items as they are negatively worded. Typical items are "The teacher considers students' feelings" (Personalization) and "Different students use different books, equipment and materials" (Differentiation). The published version of 50 items has a progressive copyright arrangement which gives permission to purchasers to make an unlimited number of copies of the questionnaire and response sheet.

2.3.4 My Class Inventory (MCI)

The MCI is a simplified version of the LEI for use with children aged 8–12 years (Fisher & Fraser, 1981; Fraser, Anderson & Walberg, 1982; Fraser & O'Brien, 1985). The MCI was developed originally for use at the primary school level, but it has been found useful with junior high and even high school students with limited reading ability. The MCI is simpler and easier to use than the LEI in a number of ways. It considers the limited attention span and possible fatigue among young students: it has only five of the LEI's original scales; the wording has been simplified for easier reading; it has only a two-point response format (Yes−No) instead of the four responses in the LEI; and students' answers are given on the questionnaire itself instead of on a separate response sheet to avoid errors in transferring responses from one sheet to another. The final version of MCI has 38 items in the five scales of Cohesiveness, Friction, Satisfaction, Difficulty and Competitiveness. Typical items are "Children are always fighting with each other" (Friction) and "Children seem to

like the class" (Satisfaction). Other response formats have been successfully used with the MCI. For example Goh, Young and Fraser (1995) successfully used a three-point response format consisting of Seldom, Sometimes and Most of the Time.

The MCI has been cross-validated and used in a number of studies. For example, Majeed, Fraser and Aldridge (2002) used the MCI (modified for Brunei context) in investigating the lower secondary mathematics classroom learning environment and its association with student satisfaction among mathematics students in Brunei Darussalam. 1,565 students from 81 classes in 15 government secondary schools were involved in the study, which revealed a satisfactory factor structure for a refined three-scale version of the MCI consisting of Cohesiveness, Difficulty and Competition. This study was the first to establish the factorial validity of the MCI. Also each scale displayed satisfactory internal consistency reliability and discriminant validity and was able to differentiate between the perceptions of students in different classrooms.

Mink and Fraser (2005) used the MCI with a sample of 120 fifth grade students in an evaluation of a K–5 mathematics program which integrates children's literature. It is entitled project SMILE (Science and Mathematics Integrated with Literacy Experiences). In this study, the MCI exhibited satisfactory internal consistency reliability and discriminant validity and was able to differentiate between the perceptions of students in different classes. Students' satisfaction was found to be greater in classrooms with a more positive learning environment experience.

Sink and Spencer (2005) carried out a study with a sample of 2,800 upper elementary-age students in England to examine the reliability and factorial validity of the MCI-SF (short form). Factor analysis and structural equation modeling results suggested that the original MCI-SF does not satisfactorily assess various dimensions of classroom climate. A revised 18-item 4-scale version (Cohesiveness, Competitiveness, Friction and Satisfaction) of the MCI-SF was tested and found to be psychometrically sound.

Scott, Fraser and Ledbetter (2008) used the MCI with 588 Grade 3–5 students in Texas in evaluating the effectiveness of instruction using a textbook, science kits, or a combination of both. Statistical analyses established the MCI to be valid and reliable

for use in this context. They found that using science kits was associated with a more positive learning environment in terms of student satisfaction and cohesiveness.

2.3.5 College and University Classroom Environment Inventory (CUCEI)

The CUCEI was developed for use in small classes of up to 30 students in colleges and university to assess the classroom environment (Fraser & Treagust, 1986; Fraser, Treagust & Dennis, 1986). The initial version of the CUCEI consisted of scales adapted from some secondary classroom level instruments, namely, the LEI, CES, and ICEQ. The final form of the CUCEI has seven scales each containing seven items: Personalization, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation and Individualization. Each item has the four responses of Strongly Agree, Agree, Disagree, and Strongly Disagree. Scoring direction is reversed for approximately half of the items. Typical items are "Activities in this class are clearly and carefully planned" (Task Orientation) and "Teaching approaches allow students to proceed at their own pace" (Individualization). The CUCEI was successfully used to assess hospital-based nursing education classroom environment in Australia (Fisher & Parkinson, 1998) and has been adapted to form new questionnaires, such as the Secondary Colleges Classroom Environment Inventory (SCCEI) (Kent & Fisher, 1997; Rickards, 1998), for use in specific settings. Fraser, Williamson and Tobin (1987) successfully used the CUCEI and School-Level Environment Questionnaire (SLEQ) to evaluate some alternative high schools in Australia in terms of both student perceptions of classroom environment and teacher perceptions of school environment. The sample consisted of 536 students in 45 classes (who responded to the CUCEI) and 106 teachers (who responded to the SLEQ).

Logan, Crump and Rennie (2006) used the modified CUCEI in two independent studies in computing classes in secondary schools and tertiary institutions in Wellington, New Zealand. The modifications included replacing the Involvement and Satisfaction scales with Cooperation and Equity and changing the response format from a four-point to a five-point rating scale (Nair & Fisher, 2000).

This first study involved 239 university students who completed the Preferred, the Actual or both versions of the CUCEI to assess the first-year students' perception of their learning environment based on the sub-groups of gender and new arrivals. The second study involved 265 Year 12 and 13 computer students who completed both the Preferred and Actual versions of the CUCEI to assess perceptions held by boys and girls and to see if there is evidence of computer culture at this level of education.

The original version of the CUCEI was not found reliable and valid in both studies as expected. Three iterations of the varimax rotation were conducted to arrive at a usable set of scales. Also negatively worded items were omitted in both studies and a whole scale was abandoned thereby reducing the scales from seven to six (Task Orientation scale in the tertiary study and the Personalization scale in the secondary study). Problems for this less-than-satisfactory performance of the CUCEI were suggested by the researchers to be attributable to inappropriate item statements for computing learning environments, the length of the survey, the response format and the negatively-worded item statements. Also the item statements in the Equity scale were very similar to the Personalization scale and this could be responsible for some of the problems occurring in the principal component axis.

2.3.6 Science Laboratory Environment Inventory (SLEI)

The SLEI was developed specifically to measure students' perceptions of the science laboratory classroom learning environment (Fraser, Giddings & McRobbie, 1995; Fraser & McRobbie, 1995; Fraser, McRobbie & Giddings, 1993). The initial version contained 72 items in the seven scales of Teacher Supportiveness, Student Cohesiveness, Open-Endedness, Integration, Organization, Rule Clarity and Material Environment. The final version has 35 items in the five scales of Student Cohesiveness, Open-Endedness, Integration, Rule Clarity, and Material Environment. There are seven items in each of the five scales. The five alternative responses are Almost Never, Seldom, Sometimes, Often, and Very Often. There are two forms, the personal and the class form, and both have actual and preferred versions (Fraser, Giddings & McRobbie, 1995). Typical items are "I use the theory from my regular science class sessions during laboratory activities" (Integration) and "We know the

results that we are supposed to get before we commence a laboratory activity" (Open-Endedness).

The initial version of the SLEI (which was the class form for measuring an individual student's perceptions of the whole class) was field tested and validated in six different countries, namely, the USA, Canada, England, Israel, Australia and Nigeria with a sample of 4,643 students in 225 laboratory classes. The personal form involves a student's perceptions of his or her own role within the class. The personal form of the SLEI was cross-nationally field tested with 5,447 students in 269 senior high school and university classes in the same six countries: the USA, Canada, England, Israel, Australia and Nigeria It was also cross-validated in Australia with 1,594 senior high school students in 92 classes (Fraser & McRobbie, 1995), 489 senior high school biology students in Australia (Fisher, Henderson & Fraser, 1997) and 1,592 grade 10 chemistry students in Singapore (Wong & Fraser, 1995).

The SLEI was cross-validated with 497 final-year secondary school chemistry students (average age of 15–16 years) in Singapore (Quek, Fraser & Wong, 2005b). Findings from data analysis revealed that the SLEI was valid, reliable and useful within the context of the study.

In Korea, Fraser and Lee (2009) successfully used and cross-validated the SLEI. In this study, the questionnaire was first translated into Korean language and then used with a sample of 439 high school science students. The SLEI was found to be valid and useful for this context.

And in the southeastern part of the United States, Lightburn and Fraser (2007) successfully used the SLEI with 761 high school biology students from 25 classes. The SLEI was also found to be valid and reliable for use within this context.

2.3.7 Constructivist Learning Environment Survey (CLES)

The CLES (Taylor, Dawson & Fraser, 1995; Taylor, Fraser & Fisher, 1997) was developed to assist researchers and teachers to assess the degree to which a classroom's environment is consistent with a constructivist epistemology (which

views learning as a cognitive process in which individuals make sense of the world in relation to the knowledge which they already have constructed, with this sense-making process involving active negotiation and consensus building), and to assist teachers to reflect on their epistemological assumptions and reshape their teaching practice. The CLES has 36 items with five response alternatives ranging from Almost Never to Almost Always. The CLES assesses either student or teacher perceptions of Personal Relevance, Uncertainty, Student Negotiation, Shared Control and Critical Voice. The plausibility of the CLES was established in small-scale classroom-based qualitative studies and its statistical integrity and robustness were validated in the USA and Australia.

The CLES 2, which is a shortened and revised version of the CLES, was developed by Johnson and McClure (2002). This shortened version is made up of 20 items in the same five scales, but with only four items per scale instead of six. Any negatively-worded item was removed. The CLES 2 was validated with 290 upper elementary, middle, and high school inservice and preservice science teachers in Minnesota, USA. Exploratory factor analysis and internal consistency reliability as well as examination of each item and of participants' questions and comments about them, led to this shortened and revised version of the CLES.

The CLES has been validated in a number of studies and in a number of countries. In Singapore, Wilks (2000) expanded and modified the CLES for use among students studying an English course called 'General Paper' (by including two new scales called Political Awareness and Ethic of Care). When Wilks administered the GPCLES to 1,046 students in 48 classes in junior colleges, the questionnaire was found valid and reliable and each scale differentiated significantly between the perceptions of students in different classrooms.

Kim, Fisher and Fraser (1999) translated the CLES into the Korean language and administered it to 1,083 science students in 24 classes in 12 schools. The original five-factor structure was replicated for the Korean language version of both an actual and a preferred form of CLES. Outcome-environment associations were reported. Lee and Fraser (2001) replicated the five-factor structure of a Korean-language version of the CLES among 440 grade 10 and 11 science students in 13 classes.

The CLES has been translated into Chinese for use in Taiwan (Aldridge, Fraser, Taylor & Chen, 2000). In this study across nations, the original English version was administered to 1,081 science students in 50 classes in Australia and the new Chinese version was administered to 1,879 science students in 50 classes in Taiwan. The same five-factor structure emerged for the CLES in the two countries and scale reliabilities were similar.

Aldridge, Fraser and Sebela (2004) administered a modified CLES to a sample of 1,864 intermediate (Grades 4–6) or senior level (Grades 7–9) learners in 43 classes in six schools in South Africa. In this study, the Critical Voice scale was omitted as a modification to suit the South African context. The a priori factor structure of the CLES (comprising 24 items in either the actual or preferred form with six items in each of the four scales of Personal Relevance, Uncertainty, Shared Control and Student Negotiation) was confirmed. This study also revealed that the CLES was reliable and valid. Important findings of the study were that students would prefer a more student-centered learning environment, and that the CLES was useful for providing feedback that can guide teachers in changing their classroom towards a more constructivist orientation.

Spinner and Fraser (2005) used the CLES with 119 students from 6 classes to assess the level of constructivistic teaching and learning practices. Ogbuehi and Fraser (2007) used the CLES and two other instruments with 661 students from 22 classrooms in 4 inner city schools in California. Their data analyses supported the factor structure, internal consistency reliability, discriminant validity and the ability to distinguish between classes.

Nix, Fraser and Ledbetter (2005) developed and administered a new form of the CLES (Comparative Student version) called the CLES-CS to 1,079 students in 59 classes in north Texas to evaluate the impact of an innovative teacher development program (based on the Integrated Science Learning Environment, ISLE, model). The a priori structure of the CLES-CS was confirmed and as well, the internal consistency reliability, discriminant validity and the ability to distinguish between classes and groups were supported. The study provided a degree of support for the ISLE program in terms of promoting constructivist-oriented teaching in school classrooms,

especially in terms of students' perceptions of the relevance of teaching and the uncertainty of science.

2.3.8 Geography Classroom Environment Inventory (GCEI)

This instrument was developed to investigate the use of computer-assisted learning in Singapore (Teh & Fraser, 1994, 1995). The GCEI also focuses on gender equity and so has the following four dimensions: Gender Equity, Investigation, Innovation, and Resource Adequacy. Each of these four scales has eight items which are scored on a five-point Likert-type scale. About half of these items are reverse scored. This instrument 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).

2.3.9 Computer Classroom Environment Inventory (CCEI)

The CCEI (Maor & Fraser, 1996) assesses students' perceptions of both inquiry and computer-based instructions. The questionnaire has five scales (Satisfaction, Investigation, Open Endedness, Material Environment, and Organisation) and 30 items which are scored on a five-point Likert-type scale. Nearly half of the items are reverse scored. The development of this instrument followed the dimensions laid down by Moos and was also based on the LEI, ICEQ and SLEI. It was used in Australia to investigate students' inquiry skills in computer-based classes with a sample of 120 Grade 11 students in seven classes in four schools and 6 teachers (Maor & Fraser, 1994). In this study, students interacted with a computerized database, Birds of Antarctica, and curriculum materials while the teacher used an inquiry approach to learning. The results of this study included cross-validation of the CCEI and the finding that students perceived their classes as more investigative and open ended, as well showing improvements in their enquiry skills.

2.3.10 Cultural Learning Environment Questionnaire (CLEQ)

The Cultural Learning Environment Questionnaire was developed to measure culturally-sensitive factors in classroom learning environment by Waldrip and Fisher (1997). The development of this instrument follows the dimensions laid down by Moos. The instrument has eight scales with 8–10 items each, giving a total of 40 items. The eight scales are Equity, Collaboration, Risk Involvement, Competition, Teacher Authority, Modelling, Congruence, and Communication. The instrument was validated in Australia when it was administered to 3,031 secondary science students in 135 classes. Dhindsa and Fraser (2004) used a modified version of the CLEQ (having only 7 of the 8 scales) with 475 teacher trainees at the University of Brunei Darussalam. Factor and reliability analyses supported the instrument's ability to evaluate six of the seven culturally-sensitive factors (excluding Teacher Authority) associated with the cultural learning environment of Brunei teacher trainees.

2.3.11 Distance and Open Learning Environment Scale (DOLES)

Jegede, Fraser and Fisher (1995) developed the Distance and Open Learning Environment Scale to assess university students' distance-education environment focusing on technology and science. The DOLES has the five main scales of Student Cohesiveness, Teacher Support, Personal Involvement and Flexibility, Task Orientation and Material Environment, and Home Environment. Optional scales are Study Center Environment and Information Technology Resources. There 52 items in all. Responses involve a five point Likert-type scale. Administration of the DOLES to 660 university students provided support for its internal consistency reliability and factor structure.

2.3.12 Socio-Cultural Environment Scale (SCES)

The Socio-Cultural Environment Scale was developed to measure students' perceptions of the socio-cultural environment of their science classroom which affects their learning (Jegede & Okebukola, 1993). The instrument has the five scales of

Authoritarianism, Goal Structure, African Worldview, Social Expectations and Sacredness of Science. There are six items in each scale making a total of 30 items. The responses are scored on a three-point Likert- type scale. Administration of the SCES to 600 senior secondary year-one students (442 boys and 158 girls) in 15 secondary schools in Nigeria provided support for its validity, internal consistency reliability and factor structure.

2.3.13 Distance Education Learning Environment Survey (DELES)

The DELES (Walker & Fraser, 2005) was developed to help investigators and practioners to assess psychosocial learning environment in tertiary distance education. The DELES has 34 items and the six psychosocial scales of Instructor Support, Student Interaction and Collaboration, Personal Relevance, Authentic Learning, Active Learning and Student Autonomy. A seventh attitudinal scale of Enjoyment of Distance Education was included so that associations between enjoyment and the six psychosocial scales could be investigated. The survey was developed and validated in three stages:

- identification of salient scales within Moos' (1974) three social organizational dimensions of Relationship, Personal Development, and System Maintenance and Change.
- writing individual items within the scales which were content validated by an international panel of experts and practitioners.
- pilot and field testing of items (in 680 responses from USA, Australia, New Zealand and Canada), followed by item analyses for reliability and construct validity.

2.3.14 Summary of Learning Environment Questionnaires

Many learning environment questionnaires have been developed over the years for use in studies following the initial work of Moos and Walberg. Table 2.1 (adapted from Fraser, 1998; Rickards, 1998) gives a brief overview of 13 classroom environment questionnaires, and the classification of their scales using Moos' (1974)

dimensions. Because the What Is Happening In this Class? (WIHIC) and Questionnaire on Teacher Interaction (QTI) were used in my study, they are discussed separately in Sections 2.4 and 2.5.

Table 2.1 Overview of Scales of 13 Classroom Environment Questionnaires

Questionnaire	Level	Scales Classified According to Moos' Scheme			
		Items Per Scale	Relationship Dimensions	Personal Development Dimensions	System Maintenance and Change Dimension
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Apathy Favouritism Cliqueness Satisfaction	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisation Democracy
My Class Inventory (MCI)	Elementary	6–9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalisation Involvement Cohesiveness Satisfaction	Task Orientation	Innovation Individualisation
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order & Organisation Rule Clarity Teacher Control Innovation
Individualized Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
Constructivist Learning Environment Survey (CLES)	Secondary	7	Personal Relevance Scientific Uncertainty	Critical Voice Shared Control	Student Negotiation
Geography Classroom Environment Inventory (GCEI)	Secondary	4	Gender Equity	Investigation Resource Adequacy	Innovation
Computer Classroom Environment Inventory (CCEI)	Secondary	5	Satisfaction	Investigation Open Endedness	Material Environment Organisation
Cultural Learning Environment Questionnaire (CLEQ)	Secondary	8–10	Gender Equity Collaboration Risk Involvement	Competition Congruence	Teacher Authority Modelling Communication
Science Laboratory Environment Inventory (SLEI)	Upper Secondary/ Higher Education	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Distance and Open Learning Environment Scale (DOLES)	Tertiary	4–12	Student Cohesiveness Teacher Support Personal Involvement & Flexibility	Task Orientation & Material Environment Technology Resources	Student Center Environment Home Environment
Distance Education Learning Environment Survey (DELES)	Tertiary	6	Instructor Support Student Interaction & Collaboration	Personal Relevance Authentic Learning Active Learning	Student Autonomy
Socio-Cultural Environment Scale (SCES)	Secondary Elementary	6	African World View	Social Expectation	Authoritarianism Goal Structure Sacredness of Science

Based partly on Fraser (1998a).

2.4 WHAT IS HAPPENING IN THIS CLASS? (WIHIC)

Because the WIHIC questionnaire was used in my study to assess students' perceptions of their classroom learning environment, it is discussed below in some detail in two separate subsections: its development (Section 2.4.1); and past studies involving its validation and use (2.4.2).

2.4.1 Development of WIHIC

The WIHIC questionnaire brings parsimony to the field of learning environment by combining modified versions of the most salient scales from a wide range of existing questionnaires with additional scales that accommodate contemporary educational concerns (e.g., equity and cooperation) (Fraser, 1998a). Based on previous studies, Fraser, Fisher and McRobbie (1996) developed this new learning environment instrument. The original 90-item nine-scale version was refined by using statistical data from 355 junior high school science students and extensive interviews. The final version of the WIHIC consists of 7 scales with 8 items each, making a total of 56 items in all. The seven scales are Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity. Table 2.2 provides a scale description and sample item for each scale in the WIHIC.

Fraser, Fisher and McRobbie (1996), in a pilot study, administered the WIHIC questionnaire to a sample of about 800 secondary school science students in 30 science classes. This led to the acceptance of this questionnaire for assessing classroom learning environments. The WIHIC has been cross-validated in many studies that are reviewed in Section 2.4.2 below.

2.4.2 Past Studies Using the WIHIC

Rawnsley and Fisher (1997) used the WIHIC in an investigation of the perceptions of 490 Grade 9 mathematics students in 23 classrooms in 14 schools in Adelaide, South Australia, and found it to be reliable and valid. This study also found that students developed more positive attitudes towards mathematics classes where teachers were supportive, promoted equity and involved students in investigation.

Table 2.2 Description and Sample item for Each Scale in the WIHIC

Scale name	Description of scale	Sample item
Student Cohesiveness	Extent to which students know, help and are supportive of one another.	I work well with other class members.
Teacher Support	Extent to which the teacher helps, befriends, trust and is interested in students.	This teacher talks with me.
Involvement	Extent to which students have attentive interest, participate in discussions.	I do additional work and enjoy the class.
Investigation	Emphasis on the skills and processes of inquiry and their use in problem solving and investigation.	I am given a choice in which investigations I do.
Task Orientation	Extent to which it is important to complete activities planned and to stay on the subject matter.	I know what has to be done in this class.
Cooperation	Extent to which students cooperate rather than compete with one another on learning tasks.	I cooperate with other students when doing work.
Equity	Extent to which students are treated equally by the teacher.	I get to use the equipment as much as other students.

Aldridge, Fraser and Huang (1999) used the WIHIC as part of a cross-national study of science classroom environments in Taiwan and Australia. The WIHIC was translated into Chinese by team members based in Taiwan. The 70-item instrument was administered to 1,081 Grade 8 and 9 general science students from 50 classes in 25 schools in Western Australia and 1,879 Grade 7–9 students from 50 classes in 25 schools in Taiwan. The instrument was reduced to 56 items after initial analyses (factor analysis with varimax rotation). Scale means from the two countries showed that Australian students perceived Teacher Support and Equity more favorably than the Taiwanese students. The data collected supported the reliability and validity of both the English and Mandarin versions of the WIHIC. The findings of this study suggested some explanations for differences and similarities between students' perceptions of learning environment in Australia and Taiwan using the qualitative data: students' perceptions of their learning environment are influenced by socio-cultural factors; the need for caution when using a questionnaire framed in a Western context in a different culture; and there are implications for future research involving cross-national studies (Aldridge & Fraser, 2000).

In Singapore, Chionh and Fraser (2009) cross-validated a version of the WIHIC questionnaire with a group of geography and mathematics students in their investigation of the relationships between classroom environment and the learning outcomes of achievement, attitudes and self-esteem. In this study, they also investigated differences in students' perceptions of their geography and mathematics classroom environments. 2,310 Secondary Four (Grade 10) students of the Express Course in 75 classes from 38 schools in Singapore were involved in the study. A 24-item semantic differential attitude instrument and a 20-item self-esteem inventory were developed and used to investigate associations between classroom environment and outcomes. The a priori factor was replicated for almost all the scales of the WIHIC. All the items had a factor loading of 0.4 or more on their own scale, and less than 0.4 on all other WIHIC scales. Mathematics and geography students were found to have similar perceptions of their learning environments. Achievement scores in classrooms perceived as having more Student Cohesiveness were better, whereas attitudes and self-esteem were more favorable in classrooms perceived to have more Teacher Support, Task Orientation and Equity.

Margianti, Fraser and Aldridge (2004) studied the influence of the classroom learning environment on students' cognitive and affective outcomes using an Indonesian version of the WIHIC. 1,056 third-year computer students in 33 classes in a private university were used in the study. Students' affective outcomes were measured using the Enjoyment of Science Lessons scale of the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981) which was translated and adopted for use in higher education classes. The perceptions of classroom environment by male and female students were also compared in the study. The WIHIC and TOSRA were found valid and reliable in this study. The magnitude of differences between male and female students' perceptions of the actual learning environment were small, with female students perceiving significantly more Task Orientation and Cooperation than male students. Male students perceived significantly more Equity than the female students.

Khine and Fisher (2001) used the WIHIC to investigate associations between students' perceptions of science classroom learning environments, their attitudinal outcomes and the cultural backgrounds of their teachers. The sample consisted of 1,188 Form 5 students in 54 classrooms in Brunei secondary schools. The result of

this study showed that the WIHIC was valid and reliable. They found that students perceived a more favorable learning environment in the classrooms of the Western teachers who were perceived to be more cohesive, supportive, cooperative, involving, task oriented and maintained better equity among the students.

Zandvliet and Fraser (2004, 2005) used the WIHIC as part of cross-national study for investigating the physical and psychosocial environment associated with classrooms using new information technologies. In this study, 1,404 students in 81 senior high school classes in Australia and Canada were used. The data collected supported the reliability and validity of the WIHIC for measuring physical and psychosocial factors in the computer classroom learning environment. The results indicated that there were statistically significant and independent associations between physical and psychosocial factors and between psychosocial factors and students' satisfaction with their learning. The qualitative results were combined with the quantitative results from this study to develop a model for educational productivity for computerized classrooms. The model included physical and psychosocial factors which together influence student attitudes in computerized learning environments.

Rickards, Bull, and Fisher (2001) used the WIHIC to investigate associations between school socio-economic and racial diversity factors and students' perceptions of their classroom learning environments. 1,720 eighth-grade science students from 65 classes in 11 middle schools in the USA were used. The result indicated that the WIHIC was a valid and reliable instrument for use with eighth-grade science classes in the USA. Regardless of school socio-economic status or racial diversity, students perceived the Task Orientation scale most positively and the Investigation scale least positively.

Fraser, Aldridge and Adolphe (in press) used the WIHIC and the TOSRA 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. 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. Adolphe and colleagues used the original WIHIC questionnaire with eight scales made up of 10 items per scale and the original version of TOSRA with seven scales made up of 10 items per

scale. The questionnaires were translated into Bahasa Indonesia for use with the Indonesian students. 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 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.

Koul and Fisher (2005) used the WIHIC, TOSRA, and the QTI to examine associations between teacher-student interactions, students' perception of their classroom learning environment, student sex and student cultural background, and student outcomes. 1,021 students in 32 science classes in seven co-educational private schools in Jammu, India were involved in the study. Data analyses supported the validity and reliability of each instrument. Multiple regression analyses showed that three scales of the WIHIC (Investigation, Task Orientation and Equity) and the QTI scale of Helping/Friendly were positively and significantly related to students' attitudes.

Kim, Fisher and Fraser (2000) used the WIHIC and QTI questionnaires to investigate classroom environment and teacher interpersonal behavior in secondary science classes in Korea. After translation into the Korean language, the questionnaires were administered to 543 students in 12 different Korean schools to investigate associations between students' attitude to science and their perceptions of the classroom environment. The cross-cultural validity of the WIHIC and QTI were supported. There were positive relationships of classroom environment and interpersonal teacher behavior with students' attitudinal outcomes.

Riah and Fraser (1998) examined chemistry classroom learning environments and their associations with students' learning outcomes. The sample consisted of 644 chemistry students from 35 classes in 23 secondary government schools in Brunei Darussalam. Students' perceptions of the classroom learning environment of chemistry theory classes were assessed with an adapted version of the What Is Happening In this Class? (WIHIC) questionnaire and the Questionnaire on Teacher Interaction (QTI). Students' perceptions of the classroom learning environment of chemistry laboratory classes were assessed by an adapted version of the Science Laboratory Environment Inventory (SLEI). Students' learning outcomes were measured by grade scores in chemistry in the public examination called the Brunei-Cambridge General Certificate of Education O-level examination at the end of upper secondary schooling, and students' attitudes in chemistry theory and laboratory classes were measured by using the Enjoyment of Science Lessons scale in the Test of Science-Related Attitudes (TOSRA). Guided by research questions, numerous statistical analyses were conducted. The findings supported the validity and reliability of the WIHIC, QTI, SLEI and TOSRA. The study revealed that, generally, students perceived their chemistry classroom learning environments as favorable. It also was found that students' perceptions of chemistry classroom environments were associated with students' learning outcomes. In particular, Teacher Support, Involvement and Task Orientation from the WIHIC and Understanding from the QTI were positively associated with attitudinal and cognitive outcomes. Investigation, Autonomy/Independence and Open-Endedness were positively associated with students' attitudinal outcomes, but negatively associated with students' achievement in chemistry. Student Cohesiveness enhanced students' cognitive outcomes, but it impaired students' attitudinal outcomes. Also the WIHIC, QT1 and SLEI all contributed unique and common variance to students' learning outcomes, suggesting that each is useful for assessing classroom environment in the same study, particularly when students' outcomes are measured in terms of students' subject matter achievement.

Allen and Fraser (2007) used a modified version of the WIHIC questionnaire in their study of parent and student perceptions of classroom learning environment and student outcomes. The sample consisted of 520 Grade 4 and 5 students aged 9–11 years from 22 classes in 3 schools and 120 of their parents in South Florida. Their

data analyses support the WIHIC's factorial validity, internal consistency reliability and ability to differentiate between the perceptions of students in different classrooms. Both students and parents preferred a more positive classroom environment than the one perceived to be actually present, but effect sizes for actual-preferred differences were larger for parents than for students. Associations were found between some learning environment dimensions (especially Task Orientation) and student outcomes (especially attitudes). Qualitative findings from this study suggested that students and parents were generally satisfied with the classroom environment, but that students would prefer more Investigation, while parents would prefer more Teacher Support.

Wolf and Fraser (2008) used the WIHIC in their study of learning environment, attitudes and achievement among middle-school science students using inquiry-based laboratory activities in New York. 1,434 students in 71 classes were involved in this study. WIHIC scales exhibited sound factorial validity and internal consistency reliability and were able to differentiate between the perceptions of students in different classes. Using a subsample of 165 students in 8 classes, they found that, relative to non-inquiry laboratory activities, inquiry instruction promoted significantly more Student Cohesiveness in the classroom. Their data analyses also revealed strong and consistent associations between student attitudes and scales of the WIHIC. However, associations between achievement and learning environment were relatively weaker.

Ogbuehi and Fraser (2007) used the WIHIC in their study of learning environment, attitudes and conceptual development associated with innovative strategies in middle-school mathematics. Their sample consisted of 661 students from 22 classrooms in California. Their data analyses supported the WIHIC's factor structure, internal consistency reliability, discriminant validity and the ability to distinguish between classes. Associations were found between learning environment and Grade 8 students' attitude towards mathematics.

In a cross-national validation of the WIHIC, Dorman (2003) used a sample of 3,980 Grade 8, 10, and 12 students from Australia, the UK, and Canada. Data analyses confirmed the validity and reliability of the WIHIC scales. The factorial invariance of model parameters across three countries, three grade levels and gender attested to the

wide applicability of the WIHIC as a valid measure of classroom psychosocial environment. Dorman (2008) used a sample of 978 secondary school students from 63 randomly-drawn classes in Queensland to investigate use of multitrait-multimethod modelling to validate actual and preferred forms of the WIHIC questionnaire. The students responded to actual and preferred forms of the WIHIC. Separate confirmatory factor analyses for the actual and preferred forms supported the seven-scale a priori structure of the instrument. Fit statistics indicated a good fit of the models to the data. The use of multitrait-multimethod modelling with the seven scales as traits and the two forms of the instrument as methods supported the WIHIC's construct validity. This research has provided strong evidence of the sound psychometric properties of the WIHIC.

Building on the strength of the WIHIC, Aldridge, Dorman and Fraser (2004) developed the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) for assessing students' perceptions of their actual and preferred classroom learning environments in technology-rich outcomes-focused learning settings. The instrument consists of the seven scales of the WIHIC (Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity) and the three new scales of Differentiation, Computer Usage, and Young Adult Ethos. In all, there was a total of 76 items in the 10 scales. Aldridge and Fraser (2008) administered the TROFLEI to 1,035 students in a Western Australian senior college where a technology-rich curriculum was taught. Factor analysis and alpha reliability coefficients confirmed the validity and the reliability of the TROFLEI.

Also, Aldridge, Dorman and Fraser (2004) used the actual and preferred forms of the TROFLEI with a sample of 1,249 high school students from Western Australia and Tasmania. Separate factor analysis for the actual and preferred forms supported the 10–scale a priori structure of the TROFLEI. The construct validity of the instrument was also supported with the use of multitrait-multimethod modeling (using the 10 scales as traits and two forms of the questionnaire as methods). The result of this research provided further evidence of the sound psychometric properties of the TROFLEI. Furthermore, Dorman and Fraser (2009) used the TROFLEI with a sample of 4,146 high school students from Western Australia and Tasmania. This study also supported the 10–scale a priori structure of the instrument.

The WIHIC has been found to be valid and reliable for investigating students' perceptions of their learning environment. Its wide use in many studies, in many countries, and for different subjects provided me with confidence in selecting the WIHIC for my research.

2.5 QUESTIONNAIRE ON TEACHER INTERACTION (QTI)

Research has shown that interpersonal teacher behavior affects student outcomes. For example, strict, leadership and friendly behavior of the teacher are positively associated with students' cognitive outcomes (Wubbels, 1993). Consequently, in addition to the use of the WIHIC in assessing students' perception of their classroom learning environment, the Questionnaire on Teacher Interaction was incorporated into my study for assessing interpersonal behaviors between teacher and students. This section discusses the development of the QTI (Section 2.5.1) and past studies involving validation and use of the QTI (Section 2.5.2).

2.5.1 Development of QTI

Wubbels, Creton, and Hooymayers (1985) developed a model to map teacher interpersonal behavior. It is based on the model for interpersonal behavior with two dimensions of influence and proximity proposed by Leary (1957) for use in psychotherapy. Because the Leary model was found unsuitable to measure teacher interpersonal behavior, Wubbels et al. (1985) mapped the behavior of teacher with a proximity dimension (Cooperation, C – Opposition, O) and influence dimension (Dominance, D – Submission, S). The dimensions are represented in a coordinate system divided into eight equal sections as shown in Figure 1. The sectors are labeled DC, CD, etc. according to their position in the coordinate system. DC and CD are both characterized by Dominance and Cooperation but, for DC, Dominance prevails over Cooperation.

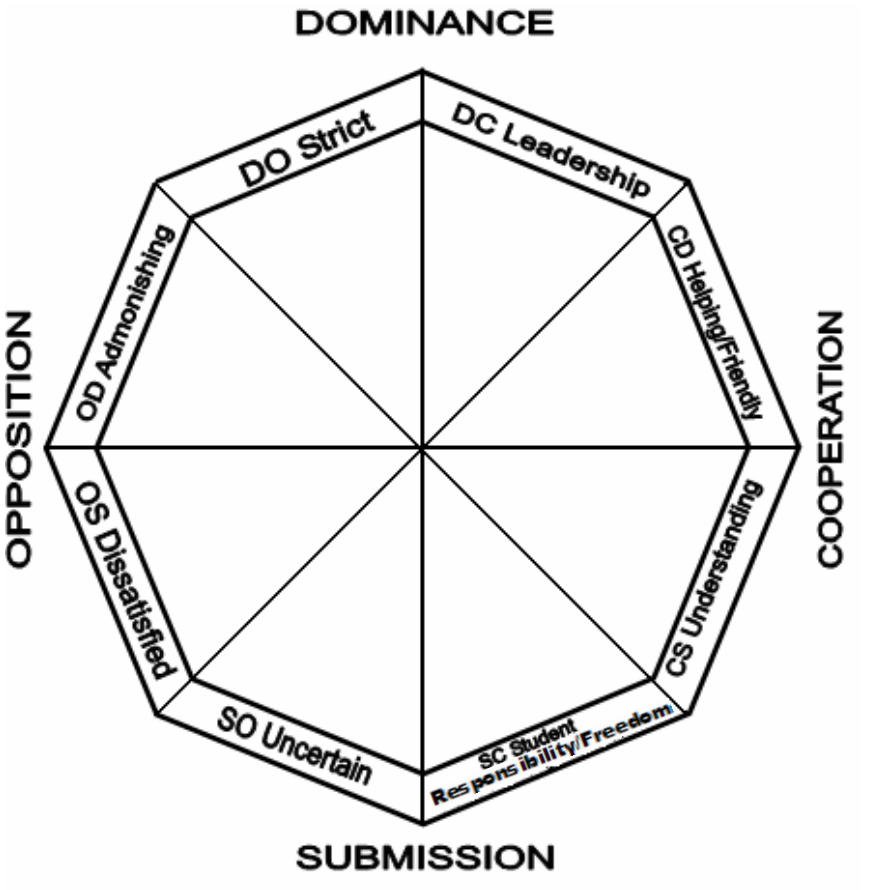

Figure 2.1 Model for Interpersonal Teacher Behavior (Source: Fisher, Fraser, & Wubbels, 1993)

The original version of the QTI was developed in the Netherlands and focuses on the nature and quality of interpersonal relationships between teachers and students (Creton, Hermans & Wubbels, 1990; Wubbels, Brekelmans & Hooymayers, 1991). The QTI was developed to assess students' perceptions of eight behavior aspects, namely, Leadership, Helping/Friendly, Understanding, Student Responsibility/ Freedom, Uncertain, Dissatisfied, Admonishing and Strict. Each item has a five-point response scale ranging from Never to Always. Typical items are "He/She gives us a lot of free time" (Student Responsibility and Freedom) and "He/She gets angry" and "He/She expresses irritation" (Admonishing behavior). Table 2.2 provides a scale description and sample item for each scale in the QTI.

TABLE 2.3 Description Scale and Sample Item for each Scale of the QTI

Scale Name	Description of Scale (The extent to which the teacher…)	Sample Item
Leadership	… leads, organizes, gives orders, determines procedure and structures the classroom situation.	This teacher talks enthusiastically about his/her subject.
Helping/Friendly	… shows interest, behaves in a friendly or considerate manner and inspires confidence and trust.	This teacher helps us with our work.
Understanding	… listens with interest, empathises, shows confidence and understanding and is open with students.	This teacher trusts us.
Student responsibility/Freedom	…gives opportunity for independent work, gives freedom and responsibility to students	We can decide some things in this teacher's class.
Uncertain	… behaves in an uncertain manner and keeps a low profile	This teacher seems uncertain.
Dissatisfied	… expresses dissatisfaction, looks unhappy, criticizes and waits for silence.	This teacher thinks that we cheat.
Admonishing	…gets angry, expresses irritation and anger, forbids and punishes.	This teacher gets angry unexpectedly.
Strict	… checks, maintains silence and strictly enforces the rules.	This teacher is strict.

The QTI exists in numerous versions. The original Dutch version of the QTI consisted of 77 items in the eight scales (Wubbels, Brekelmans & Hoomayers, 1991; Wubbels, Creton & Hoomayers, 1985; Wubbels & Levy, 1991, 1993). An English version of the QTI for use in the USA was developed in 1991 with a total of 64 items, with eight items for each of the eight scales (Wubbels & Levy, 1993). An economical short version can be used to gather information about student/teacher perceptions of the classroom environment using 48 items (Wubbels, 1993), six for every section of the model of interpersonal teacher behavior (Figure 1). The items are arranged in cyclic order and in blocks of four, with items 1 to 24 assessing Leadership , Understanding, Uncertain and Admonishing behaviors and Items 25 to 48 assessing

Helping/Friendly, Student Responsibility and Freedom, Dissatisfied and Strict behaviors (Wubbels, 1993).

All three versions of the QTI allow teachers to obtain their students' perceptions of their interpersonal behavior, their own perceptions, and the behavior that students and teachers consider to be ideal. These can be used as a basis for self-reflection by teachers on their teaching performance. Based on this information, teachers might decide to change the way in which they behave in the classroom in an attempt to create a more desirable classroom environment. Teachers can organize staff development activities accordingly to foster improvement in their interpersonal behavior with students. Also teachers can make use of the QTI to monitor students' views of their classes, investigate the impact that different interpersonal behaviors have on student outcomes, and provide a basis for guiding systematic attempts to improve this aspect of their teaching. Furthermore, the QTI could be used in assessing changes that result from the introduction of new curricula or teaching methods, and in checking whether the science teacher's interpersonal behavior is seen differently by students of different genders, abilities or ethnic backgrounds.

2.5.2 Past Studies Involving Validation and Use of QTI

In the Netherlands, the QTI was used to investigate relationships between interpersonal teacher behavior and student achievement and attitudes to science (Wubbels & Levy, 1993). 1,105 students and 66 teachers were involved in the study. The short version of the QTI with 48 items was used in the study. A five-point response format ranging from Never to Always was used. Teachers and students were asked to complete the questionnaire with teachers reporting their perceptions of their interpersonal behavior. The alpha reliability coefficient for the Helping/Friendly scale for both students and teachers was 0.78 and this was the highest of all the eight scales within QTI. The study confirmed the validity and reliability of the QTI and also found a strong positive relationship between teachers' interpersonal behaviour and student outcomes. In another study in the Netherlands, Wubbels et al. (1991) investigated relationships between perceptions on the QTI scales and student learning outcomes. They found that the Strict, Leadership and Helping/friendly behaviors were strongly and positively related to cognitive outcome scores.

Wubbels, Brekelmans, Creton, and Hoomayers (1990) used the QTI to develop typologies based on student perceptions of interpersonal teacher behaviors in The Netherlands. Characteristic teacher types were distinguished as directive, authoritative, tolerant/authoritative, tolerant, uncertain/tolerant, uncertain/aggressive, repressive and drudging. Directive and tolerant/authoritative teacher types were associated with the greatest cognitive and affective achievement of students. The uncertain/aggressive and uncertain/tolerant teacher types were associated with lowest student achievement.

Studies in the Netherlands revealed that teachers who are strict, leading and helping/friendly enhanced the achievement of their students. Student achievement was low in classrooms with high student responsibility and freedom and where teachers show uncertain and dissatisfied behaviors (Wubbels, Brekelmans, & Hoomayers, 1991). Student attitudes were strongly related to teachers' interpersonal behavior. Students had better attitudes in the classrooms of teachers who showed more cooperation. Student attitudes were related positively to Student Responsibility and Freedom, Understanding, Helping/friendly and Leadership behaviors of the teacher (Wubbels, Brekelmans, & Hoomayers, 1991).

In the USA, Wubbels and Levy (1991) used the 64-item USA version of the QTI with 1,606 students and 66 teachers. The cross-cultural validity and the usefulness of the QTI was confirmed by this study, the internal consistency reliabilities for the QTI scales ranged from 0.74 to 0.84 for teacher responses and from 0.76 to 0.84 for student responses.

In a study in Australia, the QTI was used with a sample of 792 students and 46 teachers in Western Australia and Tasmania (Fisher, Fraser, & Wubbels, 1993; Fisher, Fraser, Wubbels, & Brekelmans, 1993). They found that, generally, students perceived that the best teachers are strong leaders and more friendly and understanding, and less uncertain, dissatisfied and admonishing than are teachers on average. Also perceptions of teachers differed from those of students. The teachers tended to see the learning environment a little more favorably than did their students. Teachers had higher scores on Leadership, Helping/Friendly and Understanding

behaviors than their students. This study supported the validity and usefulness of the QTI in Australia.

In Australia, the first use of the 48-item QTI was carried out by a team of researchers in a study involving 489 students in 28 upper secondary school biology classes to investigate associations between students' perception of teacher-student interactions in science classes and student outcomes (Fisher, Henderson & Fraser, 1995). This study confirmed the reliability and validity of the QTI when used in senior secondary science classes. The alpha reliability coefficients for different QTI scales ranged from 0.63 to 0.83 with the student as unit of analysis and from 0.74 to 0.95 with the class as the unit of analysis. Generally, the dimensions of the QTI were found to be significantly associated with student attitude scores. In particular, students' attitude scores were higher in classrooms in which students perceived greater Leadership, Helping/friendly, and Understanding behaviors in their teachers.

In another study in Australia, the QTI was also found to be valid when used to assess teacher-student interpersonal relationships in mathematics classrooms (Fisher & Rickards, 1998). The study involved 405 students and 21 mathematics teachers in nine schools. Student attitude scores were similar to those found in science classrooms. Also attitude scores were higher in classrooms in which students perceived greater Leadership and Helping/friendly behaviors in their teacher and lower in classrooms in which students perceived greater Dissatisfaction, Admonishing and Strict behaviors in their teachers.

Rickards and Fisher (1998) used 153 teachers and 3,515 students from 164 secondary school science classes to assess teacher-student interpersonal behavior using three forms of the QTI (Actual, Teacher and Ideal Teacher). Teachers had a tendency to perceive their classes more positively than did students and students perceived the ideal teacher more positively than their actual teacher.

Fisher, Rickards, and Fraser (1996) used the QTI to compare teachers' and students' perceptions of interpersonal teacher behaviors. They found that science teachers, after completing the QTI and considering the results supplied to them, were stimulated to reflect on their own teaching and verbal communication in the classroom. One teacher

said that she had become more aware of her students' need for clear communication and arrived at a new point in improving her teaching strategies.

Flinn (2004) used the QTI to investigate student perceptions of their health science teachers' interpersonal behavior in health science classes in Tasmania, Australia. 1,471 Grades 9 and 10 health science students and their teachers in 75 classes participitated in the study. The QTI was found to be valid and reliable for use in health science classrooms. Associations were found between the QTI scales and the students' outcomes of attitude and achievement. The scales of Leadership and Helping/Friendly had the greatest positive correlation with students' attitudinal and achievement outcomes. Students perceived high levels of Leadership, Helping/friendly and Understanding behaviors and low levels of Uncertain, Dissatisfied and Admonishing behavior from their teachers. Less-experienced teachers were perceived as less dominant and more oppositional than more experienced teachers.

In a cross-country study in Singapore and Australia, the QTI was used in examining the perceptions of interpersonal teacher behavior in science classroom (Fisher, Goh, Wong & Rickards, 1996; Fisher, Goh, Wong & Rickards, 1997). Data were collected from 720 grades 8 and 9 students in Singapore and 705 grades 8 and 9 students from Australia who participated in the study. Generally, the dimensions of the QTI were significantly associated with science attitude scores, with students' scores being higher where students perceived higher teacher support (e.g. the Helping/friendly behavior). The researchers suggested that teachers should ensure high levels of teacher support in their classrooms in order to promote improved students' attitudes to science. In this study, students completed the 48-item Australian version of the QTI while the teachers completed the Actual and Ideal versions of the questionnaire. Australian students perceived more Helping/Friendly behavior than Singaporean students. Singaporean teachers perceived their actual interpersonal behavior to be close to their ideal, unlike Singaporean students who perceived lower Helping/Friendly behavior than their teachers. Australian teachers rated their actual behavior lower than the ideal.

The QTI was used in Singapore with 1,512 primary 5 mathematics students in 39 classes in 13 schools (Goh & Fraser 1996, 1998, 2000; Goh, Young & Fraser, 1995). The study investigated associations between student cognitive and affective outcomes and perceived patterns of teacher-student interaction. Better cognitive outcomes were found in classrooms where students perceived their classroom teacher to show more Leadership, and Helping/Friendly behaviors and less Uncertain behavior. This study also cross-validated the QTI for use in a new country and found it to be useful in several research applications.

Quek, Wong and Fraser (2005) provided further support for the validity and usefulness of the QTI in Singapore. They investigated associations between teacher-student interaction and students' attitudes towards chemistry. The sample used for this study consisted of 497 tenth-grade gifted and non-gifted chemistry students from three independent schools in Singapore. Associations were found between the interpersonal behavior of chemistry teachers and students' enjoyment of their chemistry class. Teachers' helping/friendly behavior had a statistically significant independent association with the students' enjoyment of science lesson.

Scott and Fisher (2004) translated the elementary version of the QTI into standard Malay and cross-validated it with 3,104 primary school students in 136 classes in Brunei Darussalam. Statistical analyses revealed that the Malay version of the QTI was valid and reliable. The study also found that strict teacher behavior and not allowing much student responsibility and freedom were negatively correlated with students' cognitive achievement. Students' achievement was lower in classes with teachers whom they perceived as being uncertain. Teachers' helping/friendly behavior was positively correlated with both students' cognitive achievement and their enjoyment of science lessons.

Khine and Fisher (2002) used the QTI, WIHIC and TOSRA in investigating associations between teacher interpersonal behavior and aspects of classroom environment in Brunei Darussalam. The QTI was used to measure students' perceptions of teacher interpersonal behavior and the WIHIC was used to measure the classroom climate in the science classes. The sample consisted of 1,188 Form 5 students in 54 classrooms in secondary schools. In this study, the QTI and the WIHIC

were found valid and reliable for use in Brunei. Significant associations were found between students' attitudes and most of the scales in the QTI and all the scales in the WIHIC.

The QTI was also cross-validated in Brunei with a sample of 644 Grade 10 chemistry students from 23 schools (Riah & Fraser, 1998). This study revealed that students perceived both their chemistry theory classes and laboratory classroom environment in a positive way. Associations were found between students' perception of their chemistry classroom learning environment and their learning outcomes. The Understanding scale of the QTI was positively associated with students' attitudinal and cognitive outcomes.

In Korea, Kim, Fisher & Fraser (2000) validated a Korean-language version of the QTI among 543 Grade 8 students in 12 schools. They investigated associations between students' attitudes to science and perceptions of classroom learning environment. They found that interpersonal science teacher behaviors in Korea were directive with less Leadership, Helping/friendly and Understanding behaviors. They also found positive relationships between classroom environment and interpersonal teacher behavior and students' attitudinal outcomes.

Lee, Fraser and Fisher (2003) translated the QTI into Korean and administered it to 439 Grade 10 and 11 science students (99 science-independent stream students, 195 science-oriented stream students and 145 humanities stream students). They investigated teacher-student interactions in Korean high school science classrooms. Based on the result from this survey, interviews with some students and teachers were carried out and three classrooms were observed. It was also found that students experience unique interactions in their science classroom, which was attributed to the overlapping of a teacher's personal characteristics and the nature of the stream (such as the curriculum and the expectation towards the students in that stream). The students in the science-independent stream perceived their teachers more favorably. This teacher was observed to be liberal in allowing students to talk with their peers and move around the room during lessons. In the science-oriented stream, the teacher was continuously encouraging students to get involved in the learning process. In the humanities stream, students were very passive and perceived their classrooms less

favorably than students in the science-independent stream. Humanities teachers were very didactive, conservative and traditional. Students' responses in general reflected that the science teachers are directive, controlling and not supportive of students' self-activities. It was found that teacher-student interactions in Korean senior high school science classrooms reflected the general image of the youth-elder relationship in the society, as well as the typical nature of the senior high school involving directing teachers and obeying students.

In Indonesia, Fraser, Aldridge and Soerjaningsih (2010) translated the QTI into the Indonesian language and investigated differences between students attending computer science and management classes in terms of lecturer-student interpersonal behavior. The sample consisted of 422 university students in 12 research methods classes. It was found that positive interpersonal lecturer behavior related to students' achievement and attitudes towards the internet. The QTI was found to be valid and reliable for use in this context. This study shows that even older students' achievement and attitudes relate to their perceptions of their teachers' interpersonal behavior.

In Thailand, using the QTI as one of the instruments, Kijkosol and Fisher (2004) assessed teacher-student interactions and the laboratory learning environment in biology classes. The QTI was translated into Thai and modified for use in this study. About 1,000 secondary school biology students from various schools in Thailand were involved. The QTI was found valid and reliable for use in Thailand. Positive associations were found between Leadership, Helping/Friendly and Understanding scales of the QTI and students' attitudes to biology classes.

In another study in Thailand using the QTI, Santiboon and Fisher (2005) investigated associations between students' perceptions of their physics classroom learning environment and interactions with their teachers in upper secondary school classes. The QTI was translated into Thai and administered to 4,576 grade 12 students in 245 physics classes. In this study, the QTI was found to be reliable and valid. Statistically significant differences were found between the students' perceptions of actual and preferred teacher behavior in Thailand. Students preferred to be given more responsibility and freedom and to get less uncertain, dissatisfied, admonishing and strict behavior from their teachers. This suggested that the students would prefer a

more positive learning environment than they actually perceive to be present. Associations were found between teachers' interpersonal behavior and students' attitudes and achievement in their physics classes. There were more favorable attitudes in classes where the students perceived greater leadership, helping/friendly and understanding behaviors, and where students were given responsibility/freedom.

Levy, den Brok, Wubbels and Brekelmans (2003) used the QTI in their study of variables associated with differences in perceptions of interpersonal teacher behavior. Data were collected from 3,023 students and 74 teachers in 168 classes in seven secondary schools. The QTI was found to be valid and reliable for use in this context. They found that several variables (such as students' ethnicity and gender) were significantly related to students' perceptions of their teachers' classroom interpersonal behavior.

Koul and Fisher (2005) used the QTI in their study of cultural background and students' perceptions of science classroom learning environment and teacher interpersonal behavior in Jammu, India. A sample of 1,021 students in 31 classes in seven schools was used for the study. The QTI was found valid and reliable for use in this context.

As can be seen from the above review of literature, the QTI can be used as a basis for self-reflection. In this case, the teacher completes the two teacher versions which ask the teacher to rate how they see himself/herself or how he/she sees their ideal teacher. To enable teachers to gather data about the students' perspective of the actual classroom environment and the teacher-student interpersonal behaviors in the classroom, students can be asked to complete the student version of the QTI which takes them only about 30 minutes. In all, the QTI has proved to be a valid and reliable instrument that can be used by science teachers for assessing teacher-student interpersonal behaviors in their classroom. The QTI was therefore chosen for use in my study as it has been widely used in various studies in different countries to investigate teacher-student interpersonal behaviors and has consistently been found to be valid, reliable and useful.

2.6 ASSESSMENT OF STUDENTS' ATTITUDES

One of the aims of this study was to investigate associations between learning environment, teachers' interpersonal behavior and students' attitudes. Therefore this section reviews literature about definitions of students' attitudes (Section 2.6.1) and the evaluation of student attitudes (Section 2.6.2)

2.6.1 Definitions of Student Attitudes

Shrigley, Koballa and Simpson (1988) stated that the word 'attitude' is derived from 'aptus', the Latin word for fitness or adaptedness as it relates to aptitude in its physical connotation. Attitude also has a mental connotation relating to mental preparation for action as well (Lightburn & Fraser, 2007). According to Webster's English dictionary, attitude is defined as 'your feeling about something or someone'. According to Allport (1935), attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related. Bogadus (1931) described attitude as a tendency to act towards or against some environmental factor which therefore becomes a positive or a negative value. Thurstone (1932) presented attitude as the affect for or against a psychological object.

Rosenberg and Hovland (1960) represented their conception of attitudes schematically as shown in Figure 2.2. They conceptualized three components of attitude:

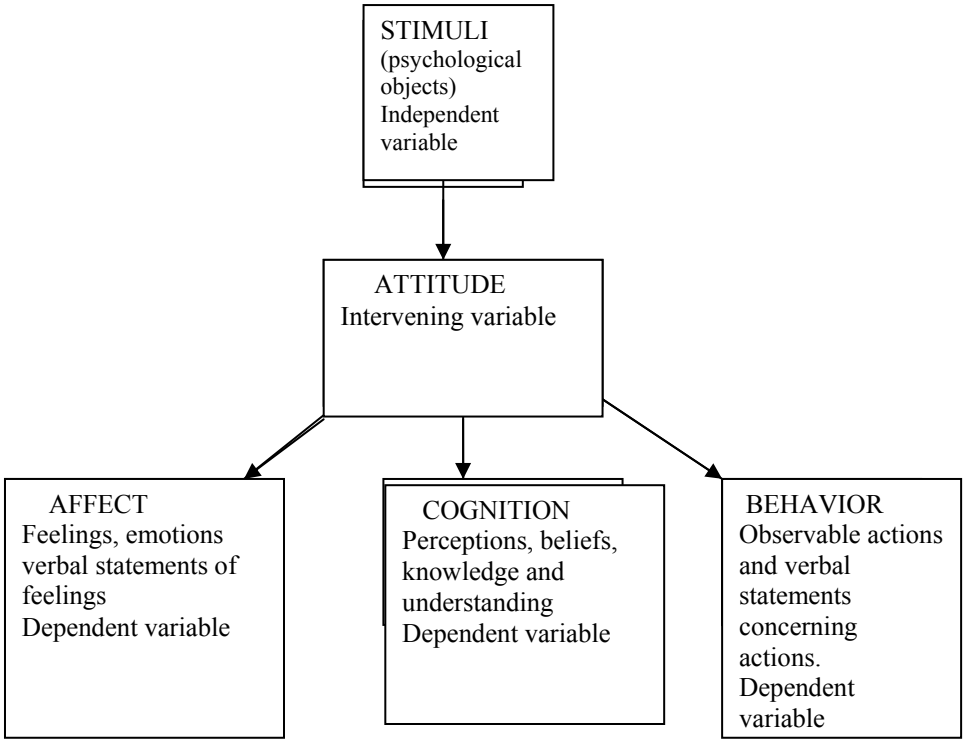

Figure 2.2 Components of attitude by Rosenberg and Hovland (1960)

- A cognitive component, consisting of concepts and propositions; a student's attitudes towards school, for example, would be linked to sets of ideas that the student has about aspects of the school.
- An affective component, comprising the emotional reactions which the person has towards the attitude object; a student's attitude to school would include feelings of pleasure or pain and liking or disliking.
- A behavioral component, a predisposition to action (e.g. a willingness to complete work or to participate in class by asking questions).

Teachers attach a wide range of meanings to the word attitude, which seems to encompass characteristics related to the quality and intensity of work that pupils do, to the nature of the student's personal relationships with the teacher and other students, and to the personality characteristics (e.g. confidence) which influence the extent to which the pupil contributes to the flow of events in the classroom (Gardner, 1981).

According to Gardner (1975), two main categories related to the attitudes concerned with science education are attitudes towards science and scientific attitudes. Gardner

defined students' attitudes towards science as "a learned disposition to evaluate in certain ways objects, people, actions, situations or propositions involved in learning science" (Gardner, 1975 p. 2). This learned disposition refers to the way in which students regard science, such as interesting, boring, dull or exciting. According to Bhaskara (1989), scientific attitude is a composite of a number of mental habits, or of tendencies to react consistently in a certain ways to a problematic situation. These habits or tendencies include accuracy, intellectual honesty, open-mindedness, suspended judgment, criticalness, and a habit of looking for true cause and effect relationships. Scientific attitude is a cognitive concept normally associated with mental processes of scientists. The current study assessed both students' attitudes towards science and scientific attitudes.

2.6.2 Evaluation of Student Attitudes

Part of the present study involved investigating associations between students' perceptions of classroom learning environment, teachers' interpersonal behavior and attitudinal outcomes. To assess the students' attitudes, two scales of the Test Of Science Related Attitudes (TOSRA) were used: Enjoyment of Science Lessons and Adoption of Scientific Attitudes. The TOSRA was developed by Fraser (1981) to measure seven distinct science-related attitudes among high school students based on Klopfer's (1971) categories for the affective domain in science education. The seven scales of TOSRA 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 has 10 items, making a total of 70 items in the TOSRA. Table 2.4 gives a description of the seven scales, the classification of each scale according to Klopfer's (1971) classification, and a sample item for each scale.

The TOSRA has some positive attributes that made it a suitable instrument for assessing students' attitudes in my study. It is useful and easy to use for measuring and monitoring science-related attitudes of an individual student or whole class as it can be used in a pretest-posttest situation to find out about changes in students' science-related attitudes over a period of time. Also the TOSRA enables researchers or teachers to obtain a 'profile' of attitude scores for a particular group of students.

Some other attitude questionnaires yield only a single overall score rather than a separate score for a number of distinct attitudinal measures.

Table 2.4 Description of TOSRA Scales

Scale	Klopfer (1971) Classification	Sample Item
Social Implications of Science	Manifestation of favorable 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 the 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 experience	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. (-)

*Adopted from Fraser (1981).

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.

Reports from past research revealed that three scales of the TOSRA (Leisure Interest in Science, Career Interest in Science, and Enjoyment of Science Lessons) overlap and can be fused into a single scale (Fraser, 1981; Khalili, 1987). Because of this overlap, some researchers select only some of the scales of the TOSRA for their research (Khine & Fisher, 2002; Scott & Fisher, 2004; Kim, Fisher & Fraser, 2000). For my study, I selected two TOSRA scales of Enjoyment of Science Lessons and Adoption of Scientific Attitudes.

2.6.3 Past Studies Involving Validation and Use of TOSRA

Fraser, Aldridge and Adolphe (in press) used the original version of the TOSRA to assess students' attitudes to science in two culturally-different countries, namely, 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). The TOSRA was translated into Indonesian for use with the Indonesian students. Principal components factor analysis followed by varimax rotation resulted in the acceptance of a revised TOSRA comprising of 20 items. The a priori factor structure of the revised

version of the TOSRA 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 more positive attitudes towards scientific inquiry, while Indonesian students had more positive attitudes towards career interest in science.

Riah and Fraser (1998) used one scale of the TOSRA, Enjoyment of Science Lessons, to assess students' attitudes in a sample of 644 chemistry students from 35 classes in 23 government secondary schools in Brunei Darussalam. Statistical analyses of their data supported the validity and reliability of the TOSRA for use within this context. Similarly, Wolf and Fraser (2008) used the same single TOSRA scale to assess students' attitudes in 1,434 students in 71 classes in New York. Principal axis factoring with oblique rotation revealed that every attitude item had a factor loading above 0.30. This supported the factorial validity of the attitude scale. Cronbach alpha coefficient analysis also supported its internal consistency reliability.

Wong and Fraser (1996) used a modified version of TOSRA, called the Questionnaire on Chemistry-Related Attitudes (QOCRA), to assess students' attitudes towards chemistry in laboratory classrooms in Singapore. The QOCRA is a shortened and modified version of the TOSRA in which the word 'science' has been replaced with 'chemistry' and also the word 'test' was replaced with the word 'questionnaire', but the original meaning of the sentences remained the same. The sample consisted of 1,592 final year (i.e. tenth grade) secondary school chemistry students in 56 intact classes in 28 randomly-selected coeducational government schools in Singapore. Statistical analyses revealed that the QOCRA was valid and reliable for use in this context. Also significant associations were found between the nature of the chemistry laboratory classroom environment and the students' attitudinal outcomes. Similarly, Quek, Wong and Fraser (2005) successfully used the QOCRA with a sample of 497 tenth grade students from three independent schools in Singapore. The QOCRA was also found valid and reliable in this study.

The TOSRA is useful and easy to use for measuring and monitoring changes in science-related attitudes of individual students or whole classes of students. For instance, it can be used in a pretest-posttest situation to monitor any changes in students' science-related attitudes. Because of the characteristics of the TOSRA listed above, I decided to use it to measure students' attitudes to science.

2.7 CHAPTER SUMMARY

This chapter has provided a review of literature relevant to the present study, including a historical perspective on the field of learning environments. Research in the field of learning environments started with the work of Lewin and Murray in the 1930s and progressed through the work undertaken by Walberg and Moos in the 1960s. Subsequently, many historically-important learning environment instruments were developed. Continuous improvement and progress have been made ever since in terms of research involving the field of learning environment. A literature review on the development of learning environment instruments was presented in Section 2.3, which included coverage of such questionnaires as the LEI, CES, ICEQ, MCI, CUCEI, SLEI, CLES, GCEI, CCEI, SCES and DELES.

Literature on the What Is Happening In this Class? (WIHIC) and the Questionnaire on Teacher Interaction (QTI) were reviewed in more detail as they were used in my study. Section 2.4 discussed the initial development and past studies involving the validation and the use of the WIHIC. Section 2.5 presented a review of literature on the development of the QTI, as well as past studies involving its validation and use. The QTI has been shown to be a valid and reliable instrument for assessing teachers' classroom interpersonal behavior in different countries and in different classroom settings. Likewise the WIHIC has proven to be valid and useful for assessing students' perceptions of classroom learning environment in different countries, with different grade levels, and in different subject areas. Thus, these two valid and reliable instruments were chosen for use in my study.

This review of literature showed that the TOSRA was found to be valid and easy to use for assessing students' attitudes towards their science classes in many previous

uses. Also the TOSRA can be easily modified and adapted for use with different subject areas.

Presented in this review of literature were several studies in which the QTI, WIHIC and TOSRA had been used in the investigation of students' perceptions of classroom learning environment, teacher-student interpersonal relationships and students' attitudes.

Section 2.6 reviewed literature on the assessment of students' attitudes (especially using the TOSRA) because investigating associations between the learning environment, teachers' interpersonal behavior and the student outcomes of attitudes and achievement was one of the aims of this study.

My study therefore builds on previous studies that were carried out in different countries.

Chapter 3

METHODOLOGY

3.1 INTRODUCTION

The purposes of this research were to:

1. Cross-validate the QTI, WIHIC, and TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with a New York sample.
2. Investigate associations between the classroom learning environment and students':
    a. Science achievement
    b. Attitudes to science
3. Investigate associations between teacher interpersonal behavior and students':
    a. Science achievement
    b. Attitudes to science.
4. Investigate the magnitude of the unique and common contributions of the WIHIC and QTI in explaining variance in students':
    a. Science achievement
    b. Attitudes to science.

In order to achieve these four aims, a step-by-step procedure had to be put in place and followed. These procedures or methods are described under the following headings:

- Preparation for the study (Section 3.2)
- Research design (Section 3.3)
- Selection and description of the sample (Section 3.4)
- Instrumentation (Section 3.5)
- Data collection (Section 3.6)
- Difficulties during data collection (Section 3.7)
- Data entry (Section 3.8)

- Data analysis (Section 3.9)
- Chapter summary (Section 3.10).

3.2 PREPARATION FOR STUDY

As mentioned before, this study investigated associations between teachers' interpersonal behavior, learning environment and students' outcomes. The first task was to choose appropriate instruments for the study. The instruments of choice were the What Is Happening In this Class? (WIHIC), Questionnaire on Teacher Interaction (QTI) and two scales of the Test Of Science-Related Attitudes (TOSRA). Because all three instruments have slightly different response formats, I came up with a common response format so that the three instruments could be administered as one to avoid too many interruptions of the Living Environment classes used for the study. The New York state Regents examination results of the students were included to assess achievement, which was one of the outcomes included in the study.

Two different methodologies (quantitative and qualitative methods) were employed in this study to obtain a more in-depth assessment of students' perceptions of their science learning environments and their perceptions of their science teachers' interpersonal behaviors. The survey instruments and achievement scores provided quantitative data, while interviews provided qualitative data which provided a comprehensive description of the learning environment. However, more emphasis was given to quantitative methods than to qualitative methods.

Letters were written to various superintendents of schools in Long Island, New York, seeking for their permission to involve some biology classes from their schools in the research. Also letters were written to many biology teachers explaining the intended study and seeking their help with questionnaire administration in their biology classes. Letters about informed consent were written to parents seeking their permission to involve their children in the research. Finally letters were written to school principals informing them about the purposes of the research and seeking their permission for their schools to be involved.

3.3 RESEARCH DESIGN

Educational researchers interested in educational evaluation have advocated the merits of combining qualitative and quantitative methods within the same study (Cook & Reichardt, 1979; Fraser & Tobin, 1991; Howe, 1988; Tobin & Fraser, 1998). This triangulation of qualitative and quantitative data can enhance the validity of the findings because a range of methods, each with its strengths and weaknesses, is used (Spinner & Fraser, 2005). Triangulation can provide support for a finding by showing that independent measures agree or at least don't contradict each other (Miles & Huberman, 1984).

The present study of associations between teachers' interpersonal behavior, the classroom learning environment and the students' outcomes of achievement and attitudes involved a number of things. First, students' perceptions of their learning environment and their perceptions of their teachers' interpersonal behavior had to be assessed. Although there are multiple methods available for doing this, a researcher must choose which model is the most suitable for the study at hand. Questionnaires offer an economical way to gather information from a large sample, but they fail to provide explanations behind the responses. Interviews can provide some of these explanations, but they are time consuming. Observations put the researcher into the actual learning environment, but they are clouded by the personal perceptions of the observer (Allen & Fraser, 2007). The methodology chosen for this study combined questionnaires and interviews. By combining multiple methods as data sources, the strengths of each method could be capitalized upon and their weaknesses could be partially overcome and also a more complete picture of the learning environment could be provided (Aldridge & Fraser, 2000; Aldridge, Fraser & Huang, 1999).

In my study, questionnaire surveys were used to gather information about students' perceptions of their learning environment and their attitudes towards their science classes, while achievement was measured by their Regents examination scores taken at the end of the school year. Perceptual measures are based on the students' experience over many lessons with the teacher, compared to data collected by an outside observer over a few lessons or a single lesson (Fraser, 1994). Also this method is economical and saves time as employing and training an outside observer is not

needed. This survey method was followed by interviewing some of the students to provide further support for the validity of students' responses to the survey.

3.4 SELECTION AND DESCRIPTION OF THE SAMPLE

Secondary school biology students from the New York area of USA were chosen for the study. The original intention was for the sample to be mainly from the Long Island area of New York. Because of the difficulties encountered during data collection, insufficient data were gathered from Long Island. The research was then extended to include schools in New York City. 785 biology students from 75 classes in five high schools in New York were involved in the present study.

All the schools involved were coeducational public schools that had a relatively even mix of males and females. The sample consisted of a very diverse range of socioeconomic and ethnic backgrounds. There were Caucasian, Black, Hispanic, Asian and Oriental students. This is a typical mix in this location.

Different parts of this study used different sample sizes. For the first research objective – involving cross-validating the QTI, WIHIC, and TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with New York – the sample consisted of 785 biology students from 75 classes.

However, to address the second and third objectives of the study, investigating associations between the students' outcomes of attitudes and science academic achievement with teacher interpersonal behavior and classroom learning environment, 603 students in 37 classes were used. This difference in sample sizes was not the original intention of the researcher. The biology Regents examination taken at the end of the school year was used to measure achievement. This examination was not taken by some of the students who were either absent or did not meet the New York state-mandated requirement of completing 1,200 minutes of laboratory investigations before taking the Regents examination. Also some schools did not release their students' Regents scores to the researcher for a variety of reasons. Some teachers said that they forgot to compile the Regent scores of the students involved in the study or

that they didn't feel comfortable releasing them. Others said that they didn't know that it was needed for the research or that they didn't think that the parents would have been happy even though the whole research process had been explained in the information/consent letters sent to parents.

Also, to address my fourth research objective concerning the unique and joint contributions of variance in student outcomes associated with the WIHIC and QTI, commonality analyses were computed using the square of the multiple correlation (R^2).

The qualitative data were gathered by interviewing a subsample of students who had completed the questionnaire. Altogether 40 students (20 boys and 20 girls) were selected for the interviews. The responses to the survey were used as a guide for this selection. The interview included both written and oral forms. Some of the students were verbally interviewed and some were given written questions to which they responded in writing. The interviews were conducted in order to support the construct validity of the questionnaires by checking consistency between scale means and students' interview comments. This enabled the researcher to gain more in-depth insights into the students' learning environment.

3.5 INSTRUMENTATION

Three instruments were used to gather data for this study. The What Is Happening In this Class? (WIHIC) was used to measure students' perceptions of their classroom learning environment. The Questionnaire on Teacher Interaction (QTI) was used to assess students' perceptions of their teacher's interpersonal behaviors. The Adoption of Scientific Attitudes and Enjoyment of Science Lessons scales from the Test Of Science-Related Attitude (TOSRA; Fraser, 1981) were selected for assessing students' science attitudes towards their science classes.

3.5.1 What is Happening In this Class? (WIHIC)

A review of literature on the WIHIC was presented in Chapter 2 in Section 2.4 including its development (Section 2.4.1) and its past uses (Section 2.4.2). Also, Table 2.2 provided a description and a sample item for each WIHIC scale.

The What Is Happening In this Class? (WIHIC) was used to measure students' perceptions of their classroom learning environment. The WIHIC (Fraser, Fisher & McRobbie, 1996) incorporates scales that have been shown in previous studies to be important predictors of outcomes and also reflects recent cognitive views of science learning (Kim, Fisher, & Fraser, 2000). A 56-item, 7-scale version of the WIHIC was used for this study to assess Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity. The WIHIC, QTI and TOSRA were given to students in the form of one questionnaire to facilitate administration. For all scales, the five response alternatives used were Almost Never, Seldom, Sometimes, Often, and Almost Always, which were scored 1, 2, 3, 4 and 5, respectively. The final questionnaire that was used is presented in Appendix D.

The validity and usefulness of the WIHIC has been demonstrated in various studies from around the world: in Singapore with 2,310 secondary four (Grade 10) students in 75 classes from 38 schools (Chionh & Fraser, 2009); in Brunei with 1,188 form 5 students in 54 classes (Khine & Fisher, 2001); in Indonesia with 1,056 third year computer students in 33 university classes (Margianti, Fraser & Aldridge, 2004); in Korea with 543 students in 12 schools (Kim, Fisher & Fraser, 2000); in India with 1,021 students in 32 classes in seven schools (Koul & Fisher, 2005); and in the USA with 1,434 students in 71 classes in New York (Wolf & Fraser, 2008), with 520 Grade 4 and 5 students in South Florida (Allen & Fraser, 2007), with 364 Grade 9 and 10 students in North Carolina (Moss, 2003), with 661 students from 22 classes in California (Ogbuehi & Fraser, 2007) and with 761 students in 25 classes in Southeastern USA (Lightburn & Fraser, 2007).

The WIHIC also has been found valid and useful in numerous cross-national studies: in Australia and Taiwan with 1,081 Grade 8 and 9 science students from 50 classes in

25 schools in Western Australia and 1,879 Grade 7–9 students from 50 classes in 25 schools in Taiwan (Aldridge, Fraser & Huang, 1999); in Australia, UK and Canada with 3,980 Grade 8, 10 and 12 students (Dorman, 2003; Dorman et al., 2003); in Australia and Indonesia with 594 students from Indonesia and 567 from Australia (Fraser et al., in press); in Australia and Canada with 1,404 students in 81 senior high school classes (Zandvliet & Fraser, 2004, 2005).

The use of multitrait-multimethod modelling with the seven scales as traits and the two forms of the instrument as methods supported the WIHIC's construct validity with a sample of 978 secondary school students in Queensland (Dorman 2009). This research has provided strong evidence of the WIHIC's sound psychometric properties.

The WIHIC was chosen for this study for the following reasons. The WIHIC is parsimonious (Fraser, McRobbie & Fisher, 1996). The wording of the items is easily understandable by the student. It can give a clear picture of what goes on in the classroom. Students are comfortable with the items as they do not directly assess their performance, personality or character. It is economical and easily administered. Its validity and usefulness has been proven in various studies from around the world. Finally its dimensions were considered salient for my study. According to Tobin and Fraser (1998), because some learning environment dimensions are more salient than others in a particular classroom, specific learning environment scales should be chosen after researchers have had some experience in the classes. The learning environment scales chosen for this study were therefore guided by past research, personal experience as a classroom teacher, and discussions with learning environment researchers.

3.5.2 Questionnaire on Teacher Interaction (QTI)

A review of literature on the QTI was presented in Chapter 2 in Section 2.5, including its development (Section 2.5.1) and its past uses and validation (Section 2.5.2). Also, Table 2.3 provided a description and a sample item for each QTI scale. The Questionnaire on Teacher Interaction (QTI; Wubbels & Brekelmans, 1998; Wubbels & Levy, 1993) was chosen to assess students' perceptions of interpersonal teacher behavior. The QTI measures student perceptions of eight behavior aspects

(Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing and Strict). This study used the 48-item version of the QTI shown in Appendix D.

The QTI has demonstrated validity and usefulness in various studies from around the world, including: Singapore with 1,512 primary 5 mathematics students in 39 classes in 13 schools (Goh & Fraser, 1996, 1998, 2000) and 497 tenth grade chemistry students from 3 schools (Quek, Wong, & Fraser, 2005); Brunei with 3,104 primary schools students in 136 classes (Scott & Fisher, 2004), 1,188 form 5 students in 54 classrooms in secondary schools (Khine & Fisher, 2002) and 644 grade 10 chemistry students from 23 schools (Riah & Fraser, 1998); Korea with 543 grade 8 students in 12 schools (Kim, Fisher & Fraser, 2000) and 439 grade 10 and 11 science students (Lee, Fraser & Fisher, 2003); Indonesia with 422 university students in 12 research methods classes (Fraser, Aldridge & Soerjaningsih, 2001); Thailand with 1,000 secondary biology students from various schools (Kijkosol & Fisher, 2004) and 4576 grade 12 students in 245 physics classes (Santiboon & Fisher, 2005); Australia with 792 students and 46 teachers in Western Australia and Tasmania (Fisher, Fraser, & Wubbels, 1993; Fisher, Fraser, Wubbels, & Brekelmans, 1993), 489 students in 28 upper secondary school biology classes (Fisher, Henderson & Fraser, 1995) and 405 students and 21 mathematics teachers in nine schools (Fisher & Rickards, 1996); and the USA with 1,606 students and 66 teachers (Wubbels & Levy, 1991).

The QTI was chosen as one of the instruments used in the present study because it is salient for the study and its dimensions assess teacher-student interactions. The QTI is presented in Appendix D.

3.5.3 Test Of Science-Related Attitude (TOSRA)

A review of literature on TOSRA was presented in Chapter 2 in Section 2.6, including its use for evaluating students' attitudes (Section 2.6.2) and its use and validation in prior research (Section 2.6.3). Also, Table 2.4 provided a description and sample item for each TOSRA scale. To assess students' attitudes in my study, two TOSRA scales were used: Enjoyment of Science Lessons and Adoption of Scientific Attitudes.

The TOSRA was developed by Fraser (1981) to measure seven distinct science-related attitudes among high school students. The TOSRA was based on Klopfer's (1971) categories for the affective domain in science education. The seven scales of TOSRA 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 has 10 items, making a total of 70 items in the TOSRA. Table 2.4 in Chapter 2 of this thesis gives a description of the seven scales, a classification of each scale according to Klopfer's (1971) scheme, and a sample item for each scale.

The two scales of the TOSRA (Enjoyment of Science Lessons and Adoption of Scientific Attitudes) used in this study are presented in Appendix D. All the reverse-scored items were removed and only five items from each of these two TOSRA scales were used.

The TOSRA has been cross-validated for use in Australia and the United States. The first sample consisted of 712 Year 7–9 students from 23 different classes each with a different teacher in eight different schools located in suburban areas of Sydney, Australia (Fraser & Butts, 1982). Lucas and Tulip (1980) used a sample of 567 Year 10 students and 273 Year 12 students in four comprehensive state high schools in Brisbane, Australia to validate the TOSRA. In the suburban area of Perth, Western Australia (Schibeci & McGaw, 1980) used a sample consisting of 1,041 Year 8–10 students from 11 schools to validate the TOSRA. In the United States, the TOSRA was used with 546 ninth grade girls in two urban Catholic schools in Philadelphia (see Fraser & Butts, 1982). Evaluations of science curricula were conducted using TOSRA by Fraser (1979) and Fisher and Fraser (1980).

Spinner and Fraser (2005) modified the TOSRA to create the Test Of Mathematics-Related Attitudes (TOMRA) for their evaluation of an innovative mathematics program in order to assess students' attitude towards mathematics. The sample consisted of 119 fifth grade students from 6 classes in Miami. Wong and Fraser (1996) used a modified version of TOSRA, called the Questionnaire on Chemistry-Related Attitudes (QOCRA), to assess students' attitudes towards chemistry in laboratory classrooms with a sample of 1,592 final year (i.e. tenth grade) secondary

school chemistry students in 56 intact classes in 28 randomly-selected coeducational government schools in Singapore. Statistical analyses revealed that the QOCRA was valid and reliable for use in this context. Similarly, Quek, Wong and Fraser (2005) successfully used the QOCRA with a sample of 497 tenth grade students from three independent schools in Singapore.

The TOSRA was chosen for use in this study because of its proven validity and usefulness in assessing students' attitudes towards science. Also it is easy to administer and its scales are salient for my study. Administering the TOSRA permitted the investigation of associations between students' perceptions of their learning environment, students' perceptions of their teachers' interpersonal behavior and the student outcomes of achievement and attitudes to science.

3.5.4 Assembling the WIHIC, QTI and TOSRA as One Instrument

As mentioned earlier in Section 3.5.1, for my study, the three instruments used (WIHIC, QTI and TOSRA) were given to students in the form of one questionnaire to facilitate administration. This approach not only reduced the response time for students, but it also minimized fatigue and avoided confusion that might arise from completing three different instruments thereby increasing the likelihood of obtaining better-quality data. For all scales, the same five response alternatives used were Almost Never, Seldom, Sometimes, Often, and Almost Always. Item responses were scored 1, 2, 3, 4 and 5, with 5 representing the most positive response. Most negatively-worded items in the two TOSRA scales used (Adoption of Scientific Attitudes and Enjoyment of Science Lessons) were avoided to minimize confusion among students. In this combined questionnaire, the WIHIC scales and items were presented first (Items 1–56) followed by the TOSRA scales (Items 57–70) and lastly the QTI scales (Items 71–118). The final questionnaire that was used is presented in Appendix D.

3.6 DATA COLLECTION

Quantitative and qualitative data were collected for the study. Quantitative data collection is discussed in Section 3.6.1, whereas qualitative data collection is discussed in Section 3.6.2

3.6.1 Quantitative Data Collection

The quantitative data were collected by using the WIHIC, QTI and two scales of the TOSRA (Enjoyment of Science Lessons and Adoption of Scientific Attitudes). For easier administration, and to minimize time taken off the learning process, the three instruments were combined and administered in the form of one survey as shown in Appendix D.

A pilot study was first conducted with 25 biology students. These students were asked to complete the questionnaire first and later they were interviewed. The pilot study was conducted by the researcher in order to check the readability and comprehensibility of the questionnaire. The purpose of the interviews was to find out if the students responded to the questionnaire items on the basis intended. The researcher also wanted to find out the approximate amount of time required to complete the survey in the pilot study so that an adequate amount of time could be allocated in the main study.

The survey data collection for the main study was not undertaken solely by the researcher. The help of other science teachers whose students were used was solicited in some cases and in some schools. Emails and telephone contacts were maintained with these teachers throughout the data collection process. These teachers were trained (informed) about how to collect the data. Some of these teachers were very willing to cooperate, but others changed their minds half way through the process. As a result, the questionnaire was not properly completed by a lot of students and therefore the responses of these students were discarded.

The questionnaires were administered towards the end of the third quarter of the school year (in March). This time of the year was chosen so that the students had

enough time to know their teachers and classmates and also to give the teachers time to establish their classroom learning environment. The questionnaires were carefully collected by class and by teacher to avoid mixing up classes which would have caused difficulties during the data-analysis stage. The questionnaires were later coded by class and teachers and schools were given their unique codes. This served the two purposes of maintaining confidentiality and avoiding the mixing up of different classes and schools. The complete questionnaire used is presented in Appendix D.

The sample initially consisted of about 950 students from 75 classes, but this was reduced to 785 students after discarding the improperly-completed questionnaires and destroying the ones completed by students who later indicated that they no longer wished to be part of the study.

3.6.2 Interviews

Students were interviewed as a means of providing qualitative data. The type of interview used was the key informant interview, which probes the views of a small number of individuals (Anderson & Arsenault, 1998). The interviews were conducted to seek support for the construct validity of the QTI, WIHIC and TOSRA by checking the consistency between scale means and interview comments. I wanted to obtain students' comments about any difficulties that they might have experienced in interpreting or understanding the items in the questionnaire.

Forty students were interviewed (20 males and 20 females) in relation to the WIHIC, QTI and TOSRA questionnaire items already completed. The students' interviews were conducted immediately after the questionnaires had been completed. During the interview, students were encouraged to expand and clarify their responses to questionnaire items (Erickson, 1998). The students were asked to comment on interview questions relevant to each individual item of the QTI, WIHIC and TOSRA scales. Notes were taken during the interview. These notes were read back to the students to ensure that the complete wording of students' comments was retained. For the written interview, the students were provided with questions broadly covering the scales of the QTI, WIHIC, and TOSRA and asked to give written responses. Some of the questions included are:

- What can you say about your science teacher's leadership skills?
- Do you perceive your science teacher to be kind and caring? Explain.
- Does your science teacher leave you without directions to figure out how to complete a task? Explain.
- Do you like to read things which disagree with your ideas, and do you dislike many trials in an experiment? Explain.
- Are you allowed to choose what investigation to do in this class or does your teacher choose all the investigations? Explain.

Oral and written interview questions used in this study are provided in Appendices E and F.

3.7 DIFFICULTIES DURING DATA COLLECTION

The researcher found out that, for the most part, conducting research using schools in New York suburban areas requires permission from the school district superintendent. Many of these superintendents refused to grant me permission to use their schools. Most of them neither returned telephone calls nor responded to emails sent to them. The only option left to me was to go to the different school district offices for a face-to-face meeting with these superintendents after speaking several times on the telephone with their secretaries to schedule a meeting. Most of them gave the identical reply that they were sorry but I could not use their schools at this time for my research. To each of these superintendents, the researcher sent a proposal that explained the purpose of the study and the fact that a code of ethics does not permit the publishing of the names of schools, teachers or students. Some principals were willing to have their schools involved but, when they heard that their superintendent did not approve, they changed their decision.

Some teachers initially got excited upon hearing about the research. But later many biology teachers who initially agreed to help suddenly changed their minds and simply said that they no longer teach biology. For the most part, only teachers personally known to the researcher and colleagues helped with the data-gathering process.

Because of this low level of cooperation, the research was expanded to include city schools. This turned out to be good as each city or urban school houses many biology classes in one building and many of the schools belong to the same school district. The suburban school districts are smaller and normally have only one high school.

Some of the students who initially completed the survey changed their minds and reported their unwillingness to continue. In these cases, questionnaires were destroyed in the presence of the student concerned. Also any written or oral interviews provided by these students were also discarded.

All these situations listed above made it impossible for the researcher to get as large a sample as initially planned.

3.8 DATA ENTRY

After collecting the completed survey, they were coded. Numerical codes were assigned to each student, each teacher and each school as well as to student gender. Each item of the QTI, WIHIC and TOSRA scales was also coded.

All the data were entered into an Excel spread sheet. Data from the questionnaire were entered manually directly off the questionnaires. In cases where a student's data were missing for numerous items, the questionnaire for that student was removed from the sample. For one missing score, an average of the last three numbers was used. For the TOSRA, a score of three was used for the missing score. The students' biology Regents scores were used for achievement and also entered into the spread sheet as percentages.

3.9 DATA ANALYSIS

The qualitative and quantitative data collected were analyzed in order to examine the reliability and validity of the questionnaires used in this study and to investigate associations between students' outcomes (attitudes and achievement) and students' perceptions of their learning environment and their teachers' interpersonal behavior.

Students' responses to the QTI, WIHIC and TOSRA scales were used for the quantitative data analysis using SPSS (version 10.0).

3.9.1 Validity and Reliability of Questionnaires

The first research objective of this study was to cross-validate the QTI, the WIHIC and the TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with a New York sample.

Validity refers to the extent to which an instrument measures what it is claimed to measure. A principal axis factor analysis with varimax rotation and Kaiser normalization was undertaken to determine whether all the items from the seven WIHIC scales (Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity) formed independent measures of the classroom learning environment. Similarly, factor analysis was conducted for items from the two scales of the TOSRA (Adoption of Scientific Attitudes and Enjoyment of Science Lessons). The analysis was undertaken with the individual student and the class as the units of analysis. Items retained in the study were those that had a factor loading of 0.40 or greater on their own scale and less than 0.40 on all other scales. Factor analysis results are presented in Chapter 4.

Reliability refers to consistency in measurement (Anderson & Arsenault, 1998). The instruments used in my study were checked for internal consistency or the extent to which each item in a scale measures the same construct (or are working in the same direction). The internal consistency reliability of each scale of the QTI, WIHIC, and TOSRA was calculated using Cronbach's alpha coefficient (Cronbach, 1951) for two units of analysis (student and class). Details of the results for internal consistency are presented in Chapter 4.

Discriminant validity analysis was undertaken for WIHIC and TOSRA scales in order to determine the extent to which a scale measures a unique dimension not measured by other scales in the instrument. The mean correlation of a scale with the other scales was used as a convenient index of discriminant validity. This was calculated with both the individual student and the class as the units of analysis.

The ability to differentiate between classrooms is another index of the validity of a learning environment instrument. Analysis of Variance (ANOVA) was used to determine the ability of each WIHIC and QTI scale to differentiate between the perceptions of students in different classes. The eta² statistic was calculated to provide an estimate of the strength of associations between class membership and the dependent variable (QTI and WIHIC) scales. The eta² is a measure of the proportion of variance accounted for by class membership and is calculated as the ratio of 'between' to 'total' sums of squares.

Based on the theoretical circumplex model of Leary (1957), the QTI's scales are expected to be correlated. For this reason, factor analyses and discriminant validity were not relevant. However, reliability, ability to differentiate between classroom and pattern of scale intercorrelations were used as indices of the validity of QTI scales using the data for 785 students in 75 biology classes.

3.9.2 Associations between Students' Outcomes and their Classroom Environment Perceptions

Two main objectives of this study were to investigate associations between: the student outcomes of attitudes and science academic achievement and teachers' interpersonal behavior; and these student outcomes and classroom learning environment. These associations were investigated by use of simple correlation and multiple regression analyses using both the individual student and the class as units of analysis.

Simple correlation coefficients were used to describe bivariate associations between each outcome (attitude and achievement) and each scale of the WIHIC and QTI questionnaires. Also multiple regression analyses, involving the whole set of scales in each environment instrument, were conducted to provide information about multivariate associations between each student outcome and each set of learning environment scales (WIHIC and QTI). Regression weights were used to indicate which individual environment scales of the WIHIC or QTI were related to an outcome (achievement or attitudes) when all the other environment scales were mutually controlled.

3.9.3 Unique and Common Variance in Student Outcomes Associated with WIHIC and QTI

The fourth objective of my study was to investigate the amounts of unique and common variance attributable to the WIHIC and QTI in explaining variance in student outcomes (attitudes and achievement). To achieve this objective, commonality analyses were computed using the square of the multiple correlations (R^2) to examine the unique and common contributions of WIHIC and QTI in explaining variance in student outcomes.

3.10 CHAPTER SUMMARY

This chapter has provided a description of the methodology used in this study. The sample sizes, preparation for the study, research design, selection and description of sample, instrumentation, and data collection, difficulties during data collection, data entry, and data analysis were presented.

Both qualitative and quantitative data were gathered for the study. Qualitative interviews were conducted to seek support for the construct validity of the QTI, WIHIC and TOSRA by checking the consistency between scale means and interview comments, to ascertain reasons for some of the students' responses to the surveys, as well as to obtain students' comments about any difficulties that they might have experienced in interpreting or understanding the items in the questionnaire. Qualitative and quantitative data were combined to provide more depth than would have been possible by using only one of the methods (Fraser & Tobin, 1991; Howe, 1988; Tobin & Fraser, 1998). The sample consisted of 785 students from 75 classes. The QTI, WIHIC, and two scales of the TOSRA (Adoption of Scientific Attitudes and Enjoyment of Science Lessons) were combined and administered as one form of questionnaire.

Students' responses to the QTI, WIHIC and TOSRA were used to check each scale's reliability. ANOVA was used to check the ability to differentiate between the perceptions of students in different classrooms for WIHIC and QTI scales. For the

WIHIC and TOSRA, factor analysis (Kim & Mueller, 1982) and discriminant validity were conducted to check scale independence.

Simple correlation coefficients were used to describe bivariate associations between each outcome (attitude and achievement) and each scale of the WIHIC and QTI questionnaires. Also multiple regression analyses, involving the whole set of scales in each environment instrument, were conducted to provide information about multivariate associations between each student outcome and each set of learning environment scales (WIHIC or QTI). Regression weights were calculated to identify which individual environment scales were related to an outcome when all other environment scales were held constant.

Commonality analyses were conducted to examine the unique and joint contributions of WIHIC and QTI in explaining variance in student outcomes.

The qualitative interview data were used to compare questionnaire scale means with students' comments for consistency.

Chapter 4

RELIABILITY AND VALIDITY OF QUESTIONNAIRES

4.1 INTRODUCTION

In the previous chapter, preparation for the study, the research design, selection and description of the sample, instrumentation, data collection, difficulties during data collection, data entry and methods of data analysis were discussed. This chapter deals with the results of analyses of the quantitative data aimed at addressing my first research objective concerning the validity and reliability of the QTI, WIHIC and TOSRA scales when used with samples of science students in New York.

The quantitative data from the study were collected from 785 biology students from 75 classes in New York. The reliability and validity of the QTI, WIHIC and TOSRA will be presented under the following headings:

- Validity and reliability of the WIHIC (Section 4.2)
- Validity and reliability of the QTI (Section 4.3)
- Validity and reliability of the TOSRA (Section 4.4)
- Interview findings as further validation of the questionnaires (Section 4.5).

4.2 VALIDITY AND RELIABILITY OF WIHIC

As mentioned previously, one of the aims of the present study was to cross-validate the WIHIC, when used with a sample of science students in New York. To check the validity and the reliability of the WIHIC, the following characteristics were investigated through statistical analyses of the data for 785 students ages 14 to 16 in 75 biology classes: factor structure, internal consistency reliability, discriminant validity and ability to differentiate between classes.

To determine the factorial validity of the WIHIC questionnaire, principal axis factor analysis followed by varimax rotation and Kaiser Normalization were conducted.

Faulty questionnaire items whose removal improved the internal consistency reliability and factorial validity of the instrument were identified by this process. All seven a priori scales of the WIHIC was retained. The criteria for the retention of any item during the factor analysis were that its factor loading must be at least 0.40 on its own scale and less than 0.40 on all of the WIHIC's other six scales. The application of these criteria led to the removal of Items 6 and 8 from the Student Cohesiveness scale. For the remaining 54 items, every WIHIC item had a factor loading of at least 0.40 on its own scale and less than 0.40 on all other scales. Table 4.1 provides the factor loadings for each WIHIC item for the sample of 785 students in 75 classes. Factor loadings less than 0.40 have been omitted in this table.

The percentage of variance explained was 2.87% (Student Cohesiveness), 4.75% (Teacher Support), 3.04% (Involvement), 37.03% (Investigation), 6.73% (Task Orientation), 3.51% (Cooperation), and 8.11% (Equity). The total was 66.05%. The eigenvalues ranged between 1.55 and 19.99 for different WIHIC scales. The factor analyses strongly support the factorial validity of the original seven-scale version of the WIHIC when used in New York.

To check the internal consistency reliability of the WIHIC, the alpha coefficient was used as the index of scale internal consistency. Internal consistency refers to the extent to which items in the same scale measure the same dimension. The reliability of each WIHIC scale was estimated using both the individual student and the class mean as the units of analysis.

Table 4.2 shows that the alpha reliability coefficient for different WIHIC scales ranged from 0.87 (Student Cohesiveness) to 0.95 (Equity) with the student as unit of analysis, and from 0.93 to 0.98 with the class as a unit of analysis. These values suggest satisfactory internal consistency reliability for all WIHIC scales. These figures are very similar to those reported by Aldridge et al. (1999), which ranged from 0.85 to 0.90 with a sample of 1,879 Grade 7–9 students from 50 classes in Taiwan.

Table 4.1 Factor Analysis Results for WIHIC

Item	Factor Loadings						
	Student Cohesiveness	Teacher Support	Involvement	Investigation	Task Orientation	Cooperation	Equity
SC01	0.66						
SC02	0.66						
SC03	0.62						
SC04	0.76						
SC05	0.60						
SC07	0.61						
TS09		0.61					
TS10		0.66					
TS11		0.74					
TS12		0.63					
TS13		0.67					
TS14		0.70					
TS15		0.56					
TS16		0.55					
IN17			0.72				
IN18			0.79				
IN19			0.45				
IN20			0.66				
IN21			0.59				
IN22			0.60				
IN23			0.44				
IN24			0.42				
IV25				0.72			
IV26				0.64			
IV27				0.78			
IV28				0.65			
IV29				0.77			
IV30				0.74			
IV31				0.78			
IV32				0.72			
TO33					0.61		
TO34					0.63		
TO35					0.69		
TO36					0.65		
TO37					0.71		
TO38					0.68		
TO39					0.71		
TO40					0.69		
CO41						0.49	
CO42						0.53	
CO43						0.56	
CO44						0.60	
CO45						0.67	
CO46						0.72	
CO47						0.68	
CO48						0.66	
EQ49							0.63
EQ50							0.70
EQ51							0.71
EQ52							0.75
EQ53							0.78
EQ54							0.76
EQ55							0.75
EQ56							0.74
% Variance	2.87	4.75	3.04	37.03	6.73	3.51	8.11
Eigenvalue	1.55	2.57	1.64	19.99	3.64	1.90	4.38

The sample consisted of 785 students in 75 classes
Principal axis factoring with varimax rotation and Kaiser normalization
Item 6 and 8 were omitted from Student Cohesiveness scale.
Factor loadings smaller than 0.40 have been omitted.
The total proportion of variance is 66.05%.

Table 4.2 Internal Consistency Reliability (Cronbach Alpha Coefficient) and Discriminant Validity (Mean Correlation of a Scale with Other Scales) for Two Units of Analysis and Ability to Differentiate Between Classrooms (ANOVA Results) for WIHIC Scales

Scale	No of Items	Unit of Analysis	Alpha Reliability	Mean Correl. with other Scales	ANOVA Eta^2
Student Cohesiveness	6	Student	0.87	0.42	0.15**
		Class	0.94	0.51	
Teacher Support	8	Student	0.92	0.51	0.19**
		Class	0.97	0.63	
Involvement	8	Student	0.91	0.51	0.14**
		Class	0.95	0.63	
Investigation	8	Student	0.94	0.48	0.15**
		Class	0.97	0.63	
Task Orientation	8	Student	0.91	0.45	0.10**
		Class	0.93	0.58	
Cooperation	8	Student	0.91	0.53	0.11**
		Class	0.94	0.64	
Equity	8	Student	0.95	0.48	0.16**
		Class	0.98	0.63	

The sample consisted of 785 students in 75 classes.
**$p<0.01$
Eta^2 is the ratio of 'between' to 'total' sums of squares and represents the proportion of variance accounted for by class membership.

Discriminant validity analysis was conducted to provide information about scale independence. The mean correlation of each scale with the other scales, with both the individual student and the class as the units of analysis, was used as an index of discriminant validity. Table 4.2 also shows that the mean correlation of one scale of the WIHIC with other scales ranged from 0.64 (Cooperation) to 0.51 (Student Cohesiveness) with the class as the unit of analysis, and from 0.42 (Student Cohesiveness) to 0.53 (Cooperation) with the student as unit of analysis. These values are small enough to suggest that each scale of the WIHIC has adequate discriminant validity and that the WIHIC assesses distinct, but somewhat overlapping aspects of classroom environment. However, the factor analysis results reported in Table 4.1 support the independence of factor scores for the WIHIC. The results with the student as the unit of analysis are similar to those reported by Aldridge et al. (1999) in Taiwan which ranged from 0.41 to 0.58 with a sample of 1,879 Grade 7–9 students from 50 classes.

An analysis of variance (ANOVA) was performed for each scale of the WIHIC to assess its ability to differentiate between the perceptions of students in different

classrooms. The last column in Table 4.2 reports the ANOVA results in terms of the eta² statistics, which is the ratio of 'between' to 'total' sums of square and represents the proportion of variance accounted for by class. The eta² statistics ranged from 0.10 to 0.19 for different WIHIC scales and was statistically significant ($p<0.01$) for each scale. This suggests that each scale of the WIHIC can differentiate significantly between classes.

Therefore, the present study replicates research (reviewed in Section 2.4.2 of the literature review) which supported the factor structure and the reliability of the WIHIC: in the USA by Wolf and Fraser (2008) with 1,434 science students in 71 classes, Allen and Fraser (2007) with 520 Grade 4 and 5 students aged 9–11 years from 22 classes in 3 schools and 120 of their parents, Ogbuehi and Fraser (2007) with 661 students from 22 classrooms in California, and Rickards, Bull, and Fisher (2001) with 1,720 eighth-grade science students from 65 classes in 11 middle schools; in India (Koul & Fisher, 2005) with 1,021 students in 32 science classes in seven co-educational private schools; in Canada (Zandvliet & Fraser, 2004, 2005) with 1,404 computing students in 81 senior high school classes; in Indonesia (Margianti, Fraser & Aldridge, 2004) with 2,498 computing students in 50 university classes; in Australia and Taiwan (Aldridge, Fraser & Huang, 1999) with a sample of 1,081 Grade 8 and 9 general science students from 50 classes in 25 schools in Western Australia and 1,879 Grade 7–9 students from 50 classes in 25 schools in Taiwan; in Singapore (Chionh & Fraser, 2009) with a sample of 2,310 Secondary Four (Grade 10) mathematics and geography students of the Express Course in 75 classes from 38 schools; in Brunei by Khine and Fisher (2000) with 1,188 Form 5 science students in 54 classrooms and Riah and Fraser (1998) with a sample of 644 chemistry students from 35 classes in 23 secondary government schools; in Australia and Indonesia by Fraser et al. (in press) with 594 students from 18 classes in Indonesia and 567 students from 18 classes in Australia; in Korea (Kim, Fisher & Fraser, 2000) with 543 science students in 12 different schools; in Australia, UK, and Canada (Dorman 2003; Dorman et al. 2003) with 3,980 Grade 8, 10, and 12 students; and in Australia by Fraser, Fisher and McRobbie (1996) with 800 secondary school science students in 30 science classes and Rawnsley and Fisher (1997) with a sample of 490 Grade 9 mathematics students in 23 classrooms in 14 schools in Adelaide, South Australia.

4.3 VALIDITY AND RELIABILITY OF QTI

Based on the theoretical circumplex model of Leary (1957), the QTI scales are expected to be correlated. For this reason, factor analyses and discriminant validity are not relevant. However, the reliability, ability to differentiate between classroom and pattern of scale intercorrelations are reported below as indices of the validity of QTI scales using the data for 785 students in 75 biology classes.

The reliability of the QTI was calculated to indicate the degree to which items in the same scale measure the same aspect of teacher-student interpersonal behavior using the alpha reliability coefficient (Cronbach, 1951). The reliability of QTI scales when used with biology students in New York is presented in Table 4.3 for two units of analysis (student and class).

Table 4.3 shows that the alpha reliability of different QTI scales ranged from 0.70 to 0.88 with the individual student as unit of analysis, and from 0.79 to 0.97 when using the class as the unit of analysis. The highest alpha reliability was obtained for the scales of Understanding and Helping/Friendly and the lowest for Student Responsibility/Freedom with the individual student as the unit of analysis. With the class as the unit of analysis, the highest alpha reliability was obtained for the scale of Understanding and the lowest for Strict behavior. This suggests satisfactory internal consistency for the QTI when used in New York. Also these figures are very similar to those reported by Wubbels and Levy (1993), which ranged from 0.76 to 0.88 with a sample of 1,606 students from 66 classes in the USA.

Analysis of variance (ANOVA) was also performed on data obtained for the QTI to investigate if each scale had the ability to differentiate between the perceptions of students from different classes. The eta² statistic, representing the proportion of variance in scale scores accounted for by class membership, ranged from 0.13 (Uncertain) to 0.29 (Understanding) and was statistically significant for each scale (see Table 4.3), therefore suggesting that the QTI was capable of differentiating significantly between classes. These figures are similar to those reported for QTI scales by Koul and Fisher (2005) which ranged from 0.13 to 0.25 with a sample of 1,021 students from 31 classes in India.

Table 4.3 Internal Consistency Reliability (Cronbach Alpha Coefficient) for Two Units of Analysis and Ability to Differentiate Between Classrooms (ANOVA Results) for QTI Scales

Scale	Unit of Analysis	Alpha Reliability	ANOVA Eta^2
Leadership	Student	0.86	0.25**
	Class	0.94	
Understanding	Student	0.88	0.29**
	Class	0.97	
Helping/Friendly	Student	0.88	0.28**
	Class	0.96	
Student Responsibility/ Freedom	Student	0.70	0.21**
	Class	0.86	
Uncertain	Student	0.83	0.13**
	Class	0.88	
Admonishing	Student	0.82	0.19**
	Class	0.88	
Dissatisfied	Student	0.87	0.16**
	Class	0.94	
Strict	Student	0.74	0.15**
	Class	0.79	

The sample consisted of 785 students in 75 classes.
**$p<0.01$
Eta^2 is the ratio of 'between' to 'total' sums of squares and represents the proportion of variance accounted for by class membership.

Further validation data for the QTI were obtained by conducting interscale correlation analysis. Because of the circular pattern or the circumplex nature of QTI, the scales are expected to be correlated. Table 4.4 provides data regarding the validity of the QTI obtained from the scale intercorrelation matrix. According to the Leary model, correlations between two adjacent scales are expected to be the highest and positive, but this correlation should gradually decrease as scales move further apart from each other until opposite scales have the highest negative correlation. Table 4.4 generally supports the circumplex model of the QTI with a few exceptions. For example, figure 4.1 shows that the Helping/Friendly scale is correlated highly and positively with Leadership (0.80) and Understanding (0.81) and this correlation decreases with the other scales until it reached the highest negative correlation of -0.49 with Dissatisfied which is directly opposite. Figure 4.1 confirms the assumptions of the circumplex model of the QTI based on the Helping/Friendly scale's correlations with its adjacent and opposite scales.

Table 4.4 Scale Intercorrelations for the QTI

Scale	Correlation							
	Leader-ship	Helping/ friendly	Under-standing	Student Resp/ Freedom	Uncer-tain	Dissat-isfied	Admon-ishing	Strict
Leadership	–	0.8	0.86	0.19	-0.34	-0.41	-0.38	-0.18
Helping/Friendly		–	0.81	0.34	-0.36	-0.49	-0.45	-0.27
Understanding			–	0.27	-0.33	-0.46	-0.45	-0.27
Student Responsibility /Freedom				–	0.38	0.24	0.19	0.11
Uncertain					–	0.72	0.74	0.5
Dissatisfied						–	0.76	0.68
Admonishing							–	0.62
Strict								–

N =785

The finding that Student Responsibility/ Freedom correlated positively with the QTI scales of Uncertain, Dissatisfied, Admonishing and Strict which has a negative connotation is an anomaly. This anomaly was explained tentatively by interview comments in which students expressed that they were given more responsibility and little or no freedom because of their badly-behaved classmates who usually could not handle any little freedom they were given. This led to the elimination of most freedom.

The present study, therefore, replicates past research (see Section 2.5.2 for literature on past studies involving validation and use of QTI) which has supported the validity and reliability of the QTI: in the USA (Wubbels & Levy, 1991) with a sample of 1,606 students and 66 teachers; in Australia by Fisher, Henderson and Fraser (1995) with a sample of 489 students in 28 upper secondary school biology classes, Fisher and Rickards (1996) with a sample of 405 mathematics students and 21 teachers in nine schools, and Flinn (2004) with a sample of 1,471 Grades 9 and 10 health science students and their teachers in 75 classes; in Singapore (Goh & Fraser, 1996, 1998, 2000; Goh, Young & Fraser, 1995) with 1,512 primary 5 mathematics students in 39 classes in 13 schools; in Brunei (Scott & Fisher, 2004) with a sample of 3,104 primary school students in 136 classes, Khine and Fisher (2002) with a sample of 1,188 Form 5 students in 54 science classrooms in secondary schools, and Riah and Fraser (1998) with a sample of 644 Grade 10 chemistry students from 23 schools; in Korea (Kim, Fisher & Fraser, 2000) with a sample of 543 Grade 8 science students in

12 schools, and Lee, Fraser and Fisher, (2003) with 439 Grade 10 and 11 science students, 99 science-independent stream students, 195 science-oriented stream students and 145 humanities stream students; in Indonesia by Soerjaningsih, Fraser and Aldridge (2001) with a sample of 422 university students in 12 research methods classes; and in Thailand by Kijkosol and Fisher (2004) with a sample of 1,194 secondary school biology students from 37 schools.

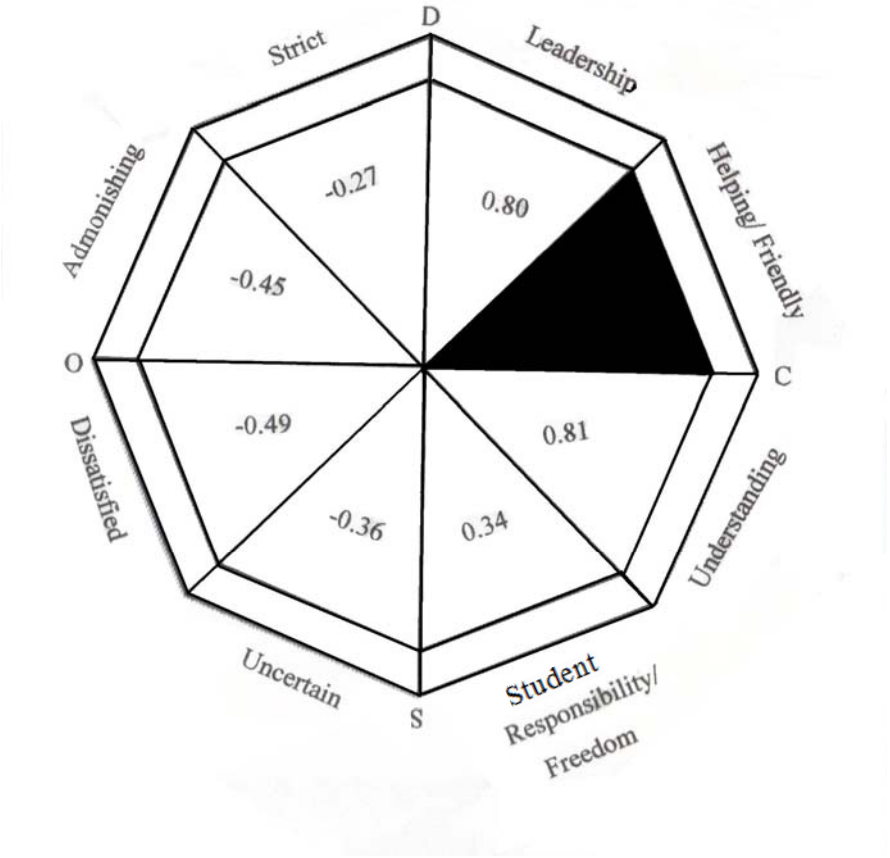

Figure 4.1 Profile of QTI Scale Intercorrelations for Helping/Friendly Scale

4.4 VALIDITY AND RELIABILITY OF TOSRA

The attitude questionnaire used in my study consisted of two scales of the TOSRA (Enjoyment of Science Lessons and Adoption of Scientific Attitudes) with 7 items each (see Section 2.6.2 and Table 2.4). To check the validity and reliability of the TOSRA, the following characteristics were investigated through statistical analyses of the data for 785 students ages 14 to 16 in 75 biology classes in New York: factor analysis, internal consistency reliability, and discriminant validity.

To determine the factorial validity of the TOSRA, principal axis factor analysis followed by varimax rotation and Kaiser normalization were conducted for the two scales of Enjoyment of Science Lessons and Adoption of Scientific Attitudes. This helped to identify faulty questionnaire items whose removal improved the internal consistency reliability and factorial validity of the instrument. The criteria for the retention of any item during the factor analysis were that its factor loading must be at least 0.40 on its own scale and less than 0.40 on the other TOSRA scale. The application of these criteria led to the removal of Items 58 and 60 from Adoption of Scientific Attitudes scale and Items 65 and 67 of Enjoyment of Science Lessons scale.

The factor analysis results are presented in Table 4.5. Factor loadings less than 0.40 have been omitted in this table. Each of the 10 remaining TOSRA items had a factor loading of at least 0.40 on its own scale and less than 0.40 on the other TOSRA scale. The percentage of variance explained by Adoption was 15.00% and for Enjoyment was 49.54%. The total proportion of variance accounted for was 64.54%. The eigenvalue was 1.50 for Adoption and 4.95 for Enjoyment. This factor analysis supports the factorial validity of the TOSRA.

Table 4.5 Factor Analysis Results for TOSRA

Item	Factor Loadings	
	Adoption	Enjoyment
ADOPT57	0.54	
ADOPT59	0.55	
ADOPT61	0.69	
ADOPT62	0.69	
ADOPT63	0.68	
ENJOY64		0.66
ENJOY66		0.63
ENJOY68		0.76
ENJOY69		0.91
ENJOY70		0.87
% Variance	15.00	49.54
Eigenvalue	1.50	4.95

The sample consisted of 785 students in 75 classes.
Principal axis factoring with varimax rotation and Kaiser normalization.
Items 58, 60, 65 and 67 were omitted.
Factor loadings smaller than 0.40 were omitted.
The total proportion of variance=64.54%

To check the reliability of the TOSRA, the alpha reliability coefficient was used as the index of scale internal consistency (the extent to which items in the same scale measure the same dimension) for two units of analysis (student and class). Table 4.6

shows that the alpha reliability of Adoption of Scientific Attitudes was 0.80 with student as the unit of analysis and 0.89 with class as the unit of analysis. The alpha reliability for Enjoyment of Science Lessons was 0.90 with the student as unit of analysis and 0.73 with the class as unit of analysis. Thus the reliability of these TOSRA scales is confirmed.

Table 4.6 Internal Consistency Reliability (Cronbach Alpha Coefficient) and Discriminant Validity (Correlation with Other Scale) for Two Units of Analysis for the TOSRA

Scale	No. of Items	Unit of Analysis	Alpha Reliability	Correlation with other Scale
Adoption of Scientific Attitudes	5	Student	0.80	0.54
		Class	0.89	0.68
Enjoyment of Science Lessons	5	Student	0.90	
		Class	0.73	

The sample consisted of 785 students in 75 classes.

Discriminant validity analysis was conducted to check the independence of the scales of the TOSRA by calculating the mean correlation of each scale with the other scale with the individual student and the class as the units of analyses. The last column in Table 4.6 also shows the mean correlation of one scale with the other scale which was 0.54 for student and 0.68 for class for the Adoption of Scientific Attitudes scale. This suggests that raw scores on the scales of the TOSRA used in this study have adequate discriminant validity but overlap to an extent. Nevertheless, the factor analysis (Table 4.5) supports the independence of factor scores on the TOSRA.

The TOSRA therefore demonstrated satisfactory factorial validity, internal consistency reliability and discriminant validity for two units of analysis (individual student and class mean). Also, the present study replicates research (see Section 2.6.3 for a literature review on past studies involving the validation and use of the TOSRA) which has supported the validity and reliability of the TOSRA: in Australia and Indonesia Fraser et al. (in press) using the original version of the TOSRA to assess students' attitudes to science with a sample of 1,161 students (594 students from 18 classes in Indonesia and 567 students from 18 classes in Australia); in Brunei by Riah and Fraser (1998) who used one scale of the TOSRA, Enjoyment of Science Lessons, to assess students' attitudes with a sample of 644 chemistry students from 35 classes in 23 government secondary schools; in the USA by Wolf and Fraser (2008) who used

the same TOSRA scale to assess students' attitudes among 1,434 students in 71 classes in New York; and in Singapore by Wong and Fraser (1996) who used a modified version of TOSRA called the Questionnaire of Chemistry-Related Attitudes (QOCRA) to assess students' attitudes towards chemistry classes with a sample of 1,592 final year (i.e. tenth grade) secondary school chemistry students in 56 intact classes in 28 randomly-selected coeducational government schools, and by Quek, Wong and Fraser (2005) who successfully used the QOCRA with a sample of 497 tenth grade students from three independent schools.

4.5 INTERVIEW FINDINGS AS FURTHER VALIDATION OF THE QUESTIONNAIRES

The questionnaires were completed by 785 biology students from 75 classrooms in New York to provide the quantitative data. Semi-structured interviews based on the questionnaires were conducted with 40 students. The interviews were conducted to check if the students interpreted the questionnaire items as intended, to clarify their responses to these items, and to check the construct validity of the questionnaires by combining qualitative and quantitative methods of data collection (Fraser & Tobin, 1991; Howe, 1988; Tobin & Fraser, 1998).

4.5.1 Introduction

During the interviews, students were asked questions related to the QTI, WIHIC and TOSRA scales. As mentioned earlier, in Chapters 1, 2 and 3, the QTI, WIHIC and two scales of the TOSRA (Enjoyment of Science Lessons and Adoption of Scientific Attitudes) used in this study were incorporated into one questionnaire. Table 4.7 provides the interview questions for each scale of the WIHIC, the QTI and the TOSRA. The questions asked by the researcher were the same for each student and requested information about each scale in turn. A numeric code from 1 to 40 was assigned to each student interviewed to maintain anonymity.

Table 4.7 Interview Questions

Learning Environment or Attitude Scale	Interview Question
Student Cohesiveness	Did your classmates know, help or support you during science activities in this classroom?
Teacher Support	Does your teacher help, support, trust and show interest in you as far as your learning activities in this classroom are concerned?
Involvement	Are you always attentive and participate well in this class?
Investigation	How often do you get to choose the investigation you do in your science class? Do you apply scientific skills and processes of inquiry in problem solving and investigations?
Task Orientation	Do you often complete planned activities and stay on the subject matter in this class?
Cooperation	Are students in this class cooperative and share their books and resources with each other when doing assignment work, team work or projects?
Equity	Does your science teacher treat everybody equally in this class?
Leadership	What can you say about your science teacher's leadership skill in terms of leading, organizing, giving orders, determining procedures and structuring the classroom situation?
Understanding	Does your science teacher listen with interest and empathy and generally show understanding and would you say that your teacher is open to you?
Helping/Friendly	Would you say that your teacher shows interest, behaves in a friendly or considerate manner and inspires confidence and trust in you?
Student Responsibility/Freedom	What can you say about your level of responsibility and freedom in this class?
Uncertain	Does your science teacher seem uncertain or keep a low profile with you?
Admonishing	Does your teacher unexpectedly get angry or punish students?
Dissatisfied	Does your teacher express dissatisfaction or look unhappy with her teaching?
Strict	Is your science teacher strict?
Adoption of Scientific Attitudes	Would you like to read things which disagree with your ideas, do you dislike many trials in an experiment, are you curious about the world, and do you view finding new things as important, listen to people with different scientific opinion, like to apply new methods in investigations, and report unexpected findings that might prove your hypothesis wrong?
Enjoyment of Science Lessons	Do you like and enjoy your science lessons?

Because the central purpose of the interviews was to check the construct validity of the questionnaires, I checked whether the interview comments made by students for each questionnaire scale were consistent with the mean for that scale. If the interview responses were consistent with the scale mean, then the construct validity of the particular scale would be supported. For all questionnaire scales, a scale mean of 1 corresponds to the response alternative of Almost Never, 2 corresponds to Seldom, 3 corresponds to Sometimes, 4 corresponds to Often and 5 corresponds to Almost Always. Therefore, I was able to use scale means to gauge whether the classroom practices assessed by a particular scale occurred Seldom, Sometimes, etc. The questionnaires used are presented in Appendix D, while the mean for each WIHIC, QTI and TOSRA scale is presented in Table 4.8.

The interview data have been grouped so that scales with similar scale means are discussed together. The mean for each scale of the questionnaires (WIHIC, QTI, and TOSRA) for the total survey sample (*N*=785) is provided in the heading of each section. For example, all the WIHIC scales with similar mean scores of 3 are grouped together in the same section for the purposes of reporting and discussion.

The QTI is made up of four scales with a positive connotation (Leadership, Helping/Friendly, Understanding and Student Responsibility/Freedom) and four scales with a negative connotation (Uncertain, Dissatisfied, Admonishing and Strict). However, although the Strict scale has a negative connotation, it has been found to correlate positively with achievement in some research in the Netherlands (Wubbels et al., 1991). For a positive learning environment, QTI scales with positive connotations would have high scale means and those with negative connotations would have low scale means. Therefore, when grouping QTI scales for discussion, I considered not only scale means, but also whether each scale has a positive or a negative connotation.

A description of each scale and sample items for the WIHIC, QTI, and TOSRA have been provided previously in Tables 2.2, 2.3 and 2.4, respectively. Table 4.8 provides the average item mean for each WIHIC, QTI and TOSRA scale. The consistency of these means with students' interview responses was checked as explained earlier in this section to support the construct validity of the questionnaires. For example, for a scale mean of 1, students' interview response would be stating that the specific activity occurs Almost Never in their classroom for the construct validity of this particular scale to be supported.

The interview findings are discussed under the following headings:

- Section 4.5.2: WIHIC scales with a mean of approximately 4 (corresponding to 'Often' response)
- Section 4.5.3: WIHIC scales with scale means of approximately 3 (corresponding to 'Sometimes' response)
- Section 4.5.4: QTI scales with a positive connotation and with a mean approaching 4 (corresponding to 'Often' response)

- ❖ Section 4.5.5: QTI scales with a negative connotation and with mean of approximately 2 (corresponding to 'Seldom' response)
- ❖ Section 4.5.6: QTI scales with a mean of approximately 3 (corresponding to 'Sometimes' response)
- ❖ Section 4.5.7: Interview results for the TOSRA scales.

4.5.2 WIHIC Scales with a Mean of Approximately 4 (Corresponding to 'Often' Response)

A scale mean of approximately 4 corresponds to the Often response and represents a fairly positive learning environment. WIHIC scales that had means in this category in descending order are Task Orientation (4.08), Student Cohesiveness (3.94), Equity (3.89), and Cooperation (3.80).

Table 4.8 Mean for WIHIC, QTI and TOSRA Scales.

Scales	Mean
WIHIC Scales	
Student Cohesiveness	3.94
Teacher Support	3.34
Involvement	3.06
Investigation	2.90
Task Orientation	4.08
Cooperation	3.80
Equity	3.89
QTI Scales	
Leadership	3.79
Helping/Friendly	3.82
Understanding	3.77
Students Responsibility/Freedom	2.73
Uncertain	2.02
Dissatisfied	2.08
Admonishing	2.30
Strict	2.76
TOSRA Scales	
Adoption of Scientific Attitude	3.37
Enjoyment of Science Lessons	3.00

N=785 Students in 75 classes.

4.5.2.1 Task Orientation (Scale Mean 4.08)

This scale assesses the extent to which it is important to complete activities planned and to stay on the subject matter. The high mean score for this scale indicated that students in this sample perceived their classes to be highly task oriented. This WIHIC

scale has the highest mean score. The interviews revealed that, because students are given marks for participation as part of their achievement grade, they generally participated and paid attention to their science classes in order to get good grades. The students' comments reflect the high mean score of 4.08 (corresponding to the 'Often' response) which support the construct validity of the scale. Students expressed their opinions as follows:

Do you often complete planned activities and stay on the subject matter in this class?

Yes we do what we have to get done first and other things can follow afterwards. (1)

Yes we always stay focused under our teachers' supervision. She will not let us do otherwise. (2)

Yes I complete planned activities and stay on subject matter in this class because, if I don't, I wouldn't be doing as well as I am doing presently. (4)

Yes, in this class, we always finish our reports, class work and projects as this is how we get our grades. (6)

Every student interviewed recognized the importance of completing and handing in work on time as well as staying on task in class. However, a few students reported that they were not always able to do so. Some of their comments are as follows:

I stay on task and complete work only on some activities. I do not do all work, especially if the teacher doesn't explain it good then I won't do the work. (9)

Yes I complete most work but, when I don't, the teacher lets me know what I need to get done. (11)

Yes I often complete all planned activities and try to stay on the subject matter, but sometimes I hand in work late. This affects my grade though because the consequence of handing in work late is that you lose some points for every day that the work is late. If you are absent, you are still responsible for getting the work done but you may not

loose points for lateness depending on the due date that the teacher now gives you. (15)

4.5.2.2 Student Cohesiveness (Scale Mean 3.94)

This scale deals with the cohesion among students, such as whether students are friendly and help and support each other in their science classroom learning activities. From the results of the interview, it appeared that some of the students were likely to know, help and support other students. However, a few of the students have negative comments about the cohesiveness of students in their science class. This reflects the item mean of 3.94 and supports the construct validity. The question used to validate students' responses to this scale was:

Did your classmates know, help or support you during science activities in this classroom?

Yes we all look out for each other and remain encouraging under the leadership of our teacher who will not tolerate students putting down each other in her class. (1)

Yes we are all friendly in this class and help and support each other every day. (5)

Yes the students in this class are helpful to me and very supportive of my science learning. When I need answers for something I don't know or understand, my classmates are willing to give them to me and, when I need to laugh, my classmates are there too. (11)

A few negative comments were given as follows:

Sometimes my classmates are nice and willing to work with me to get the science work done, but sometimes they are not as nice. (13)

No most of the students in my class are loud and annoying. I prefer to do my own work and seek help from the teacher who is always there to help me. (17)

No, not all the time, they can be really annoying and discouraging sometimes. Some of them will like to tell stories all the time but my science teacher always move around the room and tell everyone to be on task. Sometimes they get into trouble. (21)

4.5.2.3 Equity (Scale Mean 3.89)

The Equity scale measures the extent to which students are treated equally by the teacher. Most of the students interviewed stated that their teacher tries to treat everybody equally. They also stated that this is not always possible as disruptive students have to be properly dealt with so that they will allow others to learn and get ready for the Regents examination. There were very few negative responses. The majority of the students interviewed thought that the teacher is justified in treating disruptive students in a certain way so as to maintain order and an environment in which learning can occur. Students generally agreed that rules and class routines have to be followed by all students. The students' responses reflect the high scale mean of 3.89. Students expressed their opinion by responding to the following interview question:

Does your science teacher treat everybody equally in this class?

Yes my teacher takes special care to see that everybody receive about the same type of treatment. If you break the class rule, you get whatever the consequence for breaking that rule is. Some students like to do the wrong things sometimes and so they just face the music because my teacher will not let you get away with it just like that. (4)

Yes my science teacher treats everyone the same way. The same rules and consequences apply to all. If you act up, my teacher will direct more questions to you. So you are better off behaving yourself. (6)

Yes my teacher treats everyone the same and that is the great thing that I admire about her. It is not easy to consistently do this. As a student, I don't and cannot like people who are nasty to me or even try to treat them with any kind of respect. (31)

Yes my science teacher treats everyone the same. It is the kids' behavior problems that make them get a different treatment due to the fact that there are consequences for choosing to do the wrong thing. (32)

My science teacher treats every one the same way but, if you misbehave, you get rights taken away from you. (14)
Yes my teacher treats everybody the same way. The teacher gives people chances to do the right thing but the bad kids do not use the opportunity. So they get what they deserve. This class is an important Regents class and so people should not come here acting in a bad way. (15)

Few students have a negative comment about equity. It was discovered that these were mostly the disruptive students who oppose rules. These negative comments are as follows:

No, those who have a history of behaving badly and being very disruptive are thrown out faster by my science teacher. The explanation is that, since they are not ready to behave and learn, they should not be allowed to steal quality learning time from the others. They are given chances to calm down though, but some kids once they start they don't like to stop. I personally don't like to be thrown out. (9)

No, some few she will treat alright and then others the teacher goes on the offence. I don't think she treats everybody really the same way. (10)

4.5.2.4 Cooperation (Scale Mean 3.80)

This scale assesses the extent to which students cooperate with one another on learning task such as team work and projects. The interviews generally revealed that most of the students think that it is important to help one another rather than compete against each other. This reflects the high scale mean of 3.80 for Cooperation. The students' responses to this scale were very similar to their responses to the Cohesiveness scale, which had a slightly higher scale mean of 3.94. Students were asked to voice their opinions by responding to the following question:

Are students in this class cooperative rather than competing with each other?

In this science class, we mostly support each other to get our work done. I think this is better than keeping it all to yourself and scoring higher than others if you know or understand something more than them. (1)

We cooperate and work well with each other and also we encourage each other a lot. We are like a family under the leadership of our science teacher. (2)

Most times we cooperate with each other rather than compete. Sometimes the boys like to beat each other with higher grades. (3)

We help and support each other rather than compete against each other. This is not a sports game where you compete to win. (4)

We are all friendly and nice to each other. Sometimes a little competition won't hurt as this makes me study extra and prepare better for tests. (5)

Some of the students in my class are competitive but they do it silently. They like to have the highest grade each Monday when the science teacher posts our current grades to let us know how we are doing. (7)

Yes but very few students are like that. My science teacher encourages us to support and help one another. (9)

4.5.3 WIHIC Scales with Scale Means of Approximately 3.00 (Corresponding to 'Sometimes' Response)

A scale mean of 3.00 corresponds to a frequency of Sometimes for the occurrence of a practice. Scales that had means under this category in descending order include Teacher Support (3.34), Involvement (3.06) and Investigation (2.90). Interview findings for these scales are discussed below.

4.5.3.1 Teacher Support (Scale Mean 3.34)

This scale assesses the extent to which the teacher helps, befriends, trusts and is interested in students. Most of the students' responses were positive. Most students think that the teacher cares about their learning and gives them the needed support. At the same time, fewer students gave highly negative responses. They didn't really think that their science teacher cares or gives them enough support. This reflects the scale mean of 3.34.

Students were asked the following question:

Does your teacher help, support, trust and show interest in you as far as your learning activities in this classroom is concerned?

Yes she goes into a lot of detail with notes to make us understand. If we review the notes it helps us to remember things more. (4)

Yes I will say that my science teacher helps supports and shows interest in my science learning. She checks on us when we are assigned work sheets to make sure we understand. (5)

Yes she is supportive in teaching and our learning. How do I know? She walks round the room to talk to us while we do work. In this class, she asks questions about the work to check our understanding. (6)

Yes she gives a lot of support. I think that she really cares. Even when students ask the same question that has just been fully explained, she leads the students to the answers by making them listen to another student explain it again. (7)

Yes she pushes us to do better. She does not accept "I can't do it from us. (8)

Yes she gives us enough support, she tells us how we can study to pass and she always invites us to come for extra help with our problems and allow us to make up missed work. (11)

Yes our teacher always gives us a chance. Our teacher is truly encouraging and supportive. Those who make good use of opportunities should do well in this class. (12)

At the same time, some students responded negatively as follows:

Not exactly, sometimes the teacher helps me sometimes she won't. (10) [This student was then asked to further clarify when the teacher refuses her help.] *Well, as a teacher, it is her job to explain things to me even if I did not pay attention while she was initially explaining it.*

No because my science teacher ignores me when I have a question about the topic. (21) [This student was asked to clarify what she means by saying that the teacher ignores her whenever she has a question.] *Well, the teacher should be there for the student no matter what. I may have been engaged with something else initially. The teacher always expects everybody to listen to the lesson, which is not always convenient.*

4.5.3.2 Involvement (Scale Mean 3.06)

The involvement scale assesses the extent to which students have attentive interest and participate in discussions. The interviews indicated that a good number of the students participate and pay attention in class. Other students indicated that they were not able to participate and pay attention as much as they would like due to the fact that they were either tired or hungry. One of the students simply puts no effort into participating and another one really thinks that the teacher doesn't give her enough support and, for that reason, does not like to participate. One student does not participate well because of a very short attention span. This is consistent with the scale mean of 3.06 (the Sometimes response) and supports the construct validity of the Involvement scale. Students were asked the following question:

Are you always attentive and participate well in this class?

Yes I pay attention and answer questions in my science class. Participation is part of our grade. I want a good science grade. (5)

I am mostly attentive in my science class and I get involved too. (6)

Yes I participate in class and pay attention. Like yesterday I was answering questions all period long. I hope the teacher gave me some points on my participation grade. (11)

Yes I like to participate and pay attention in my science class. My favorite thing is reading aloud in class. (31)

Some of the students interviewed commented that they would have participated more than they did except for various reasons as follows;

Yes I try to participate and pay attention but some days I don't want to and it bothers me when the teacher makes me participate. (25)

I participate and pay attention at times when I'm in a good mood or not hungry and tired. (26)

I tend to participate unless when class become tedious or simply dull. (28)

Further comment from the student with short attention and the student who does not like to participate are as follows:

No I don't pay attention in my science class and I don't like to participate. (29)

Well I am as attentive as a child. (33)

4.5.3.3 Investigation (Scale Mean 2.90)

This scale focuses on the skills and the processes of inquiry and their use in problem solving and investigation**.** The interview results show that the students do investigations, but, almost all of them claimed that they don't get to choose the investigations and they mostly perceive this negatively. A few students think that it is for the best that the teacher chooses all the investigations. They mostly talked about

the scientific skills that have to be applied in doing these investigations. This is consistent with the scale mean of 2.90 (approximately corresponding with the Sometimes response). This supports the construct validity of the scale.

The interview question used to assess students' opinion was:

How often do you get to choose the investigation you do in your science class? Do you apply scientific skills and process of inquiry in problem solving and investigations?

The teacher only lets us choose our own if it is for a science project because the project is supposed to be on something you are interested in. (5)

The teacher lets us choose our own project. Laboratory investigation is more like pre-decided and we just have to do it even if we are not interested in it. Every investigation chosen by the teacher must be done. (6)

Our teacher chooses all the investigations we do based on what we learned the day before. We use the scientific method skills like observations, measurement and so on. (12)

The teacher chooses them but I think it is better that way because if the students choose it, there may be too much frustration. (14)

The teacher chooses all the investigations. I guess it is because she wants the best for us and something easier to learn following the scientific method. Not all the steps of the scientific method are involved in every single investigation. For example, some investigations don't have graphs. (34)

It depends; sometimes we choose, other times the teacher does. The stress is always on knowing how to carry out an investigation and properly report the findings, making good observations. I love to plot graphs if they are not complicated, but I don't like complicated graphs. (40)

The students' comments here are mostly pointing to the fact that most of the investigations are chosen by the teacher, which reflects the low scale mean of 2.90 (corresponding to the Sometimes response), thereby supporting the construct validity of the scale.

4.5.4 QTI Scales with a Positive Connotation and with a Mean Approaching 4 (Corresponding to 'Often' Response)

A scale mean of approximately 4 represents positive teacher interpersonal behavior for the first four scales of the QTI, which have a positive connotation. Scales that had mean of approaching 4, in descending order, include Helping/Friendly (3.82), Leadership (3.79) and Understanding (3.77).

4.5.4.1 Helping/Friendly (Scale Mean 3.82)

This scale assesses the extent to which the teacher shows interest, behaves in a friendly or considerate manner and inspires confidence and trust. The majority of the students interviewed thought that their science teacher is very helpful and sometimes friendly. The students' responses reflect the scale mean of 3.82 which supports the construct validity of this scale which has a positive connotation. The students expressed their opinion to the following question:

Would you say that your teacher shows interest, behaves in a friendly or considerate manner, and inspires confidence and trust in you?

Yes my science teacher is helpful and friendly. She takes time out to go over questions that the whole class needs help with. (2)

Yes my science teacher is extremely helpful and friendly too. She cares about our education and she is nice. She makes hard tasks seem easy. (4)

Yes she gives good answers to our problems. My teacher makes me feel good about my self and always tells me that I can do things that I thought I couldn't. (7)

Yes my teacher helps me. My teacher is kind and helpful and that makes me feel good about this class. I know that my teacher is there to help me not to criticize. (11)

My teacher is helpful and friendly because most times, when people have questions, she answers them nicely. She shows people respect all the time. (12)

My science teacher is mostly friendly but sometimes she is mean, especially when I call out. She puts on her serious look which sends me a strong signal to behave. I think this her non-verbal cue is considerate because this makes me to sit up and do the right thing without the teacher yelling at me. (15)

My teacher is a very helpful and friendly person who helps me by seeing to it that I complete tasks on time and constantly says "way to go, keep it up, at this rate you can easily make an A+ grade in your Regents examination". This gives me so much confidence. I used to be in a class with a lot of special education students even though I was never classified as one. I used to wonder if I am slow or borderline but, with this science teacher, I gained a lot of confidence and no longer think that I may be slow. I feel smart in this class. (16)

My teacher is not helpful and friendly to me. The teacher ignores most of my questions or cuts me off. [This student was asked to be specific or cite some examples of when the teacher ignores her or cuts her off.] *Well when I try to tell the class or the teacher stories of some interesting movies that I watched, she cuts it shot or tries to stop me with the same excuse that it is not related to the topic. These are things that I find interesting and do have some questions about.* (21)

4.5.4.2 Leadership (Scale Mean 3.79)

The leadership scale assesses the extent to which the teacher leads, organizes, gives orders, determines procedures and structures the classroom situations. Overall the interviews revealed that the students mostly perceived their teacher as a good leader. However, some students considered that she is too strict. At the same time, students think that their teacher's leadership behavior is beneficial as the only way to get some of the poorly behaved kids in line. This reflects the scale mean of 3.79 with the

student as unit of analysis. The students provided their opinions in relation to the following question:

What can you say about your science teacher's leadership skill in terms of leading, organizing, giving orders, determining procedures and structuring the classroom situation?

My science teacher's leadership skill is good. This teacher can take control of the class easily without a problem; she is fully in charge at all times. (6)

My science teacher is the best and kindest teacher I ever had. She is in full control of the class. She is a very good leader. (7)

My science teacher is a decent leader. The only problem is that sometimes she gets a little too strict. The strictness has some advantage though as this is taken as a serious and work mood by some kids who will do no work otherwise. (10)

My teacher's leadership skill is good. My teacher can lead the class very well to perform different tasks such as laboratory investigations. She makes sure that, during laboratory work, every single student follows the safety rules. If not, you will be removed from the group and you get a grade of zero. This rule was firmly set up at the beginning of the school year and my teacher made sure that it was followed all the time with no exceptions. She enforces all the rules very firmly which makes her seem strict but it is good. (13)

My science teacher is not only a good leader but a good person overall. She really tries to understand and listen to the students. You cannot afford to be lazy in this teacher's class because she will be on your case all the time until you do the right thing. (31)

4.5.4.3 Understanding (Scale Mean 3.77)

This scale assesses the extent to which the teacher listens with interest, empathizes, shows confidence and understanding, and is open with students. The students responded to the following question to express their opinions:

Does your science teacher listen with interest, empathize and generally show understanding, and would you say that your teacher is open to you?

I think my science teacher is very understanding because she is willing to extend the amount of time we spend on a task if the majority of students need more time. She times activities and lets us know how much time we have to spend on each one. This is mostly to get students to focus and get their work done. Class work counts as part of our grades. (3)

My science teacher is very understanding; she explains things well and listens to our ideas with keen interest. She patiently listens to our ideas even if they are incorrect before correcting you or involving other students who may have more accurate ideas. (4)

My teacher understands. If you appear unusually tired and sleepy in class, her first action is not to yell at you. Instead, she will quietly ask why you are sleeping or just putting your head on the table and she always offers good advice depending on what the case may be. (6)

Yes my science teacher does listen with genuine interest and understands students' need. In my time of need when I was sick and missed many days of school, she understood that perfectly, offered me a lot of extra help and gave me chance to catch up, which was not the same experience I had with some other teachers who just gave me the pile of work and accompanied frustration and anxiety of falling behind. I have a lot of respect for this teacher. (8)

Some of the students didn't think that their teacher completely understood and had these to say:

Not really. My science teacher does not understand or leave you alone when you don't feel like doing any work. She just urges you on to work and says "conquer your laziness and do something, and don't destroy your grade because of laziness". This does not show understanding to me. (26)

My teacher sometimes understands. When I ask a question, she sometimes gives an explanation but does not completely answer the question. She wants you to use the explanations to figure out the answer instead of giving you the exact answer. (14)

I don't completely think so because sometimes she moves too fast on work and going over work. I missed school a lot and when she just goes over stuff quickly I feel lost. I don't like to complain because she will invite me to extra help, which I don't like as it is only after school. (17)

4.5.5 QTI scales with a Negative Connotation and with Mean of Approximately 2 (Corresponding to 'Seldom' Response)

All the scales in this category are those with negative connotations which are expected to have a low score in a positive learning environment. Included are Uncertain (2.02), Dissatisfied (2.08) and Admonishing (2.30). For a positive teacher-student relationship in a positive classroom learning environment, these scales are expected to have a low mean score.

4.5.5.1 Uncertain (Scale Mean 2.02)

This scale assesses the extent to which the teacher behaves in an uncertain manner and keeps a low profile. Most of the students interviewed stated that their science teacher is never uncertain, but has a presence in the room. The low scale mean of 2.02 shows that the teacher seldom shows uncertain behaviors. Only two students said that their teacher seems uncertain sometimes, but not often. As mentioned earlier, Uncertain has a negative connotation in the interpersonal behavior model and so its low occurrence indicates a positive classroom learning environment. The students were asked to comment on the following question:

Does your science teacher seem uncertain or keep a low profile?

No, she certainly wants to be our teacher and does it very well. She is smart and knows current discoveries in science. She discusses current events in class with confidence and connects them to what we are currently learning or uses them as a review for things we learned already. (2)

No my teacher is never uncertain. Some topics are not as easy to teach or learn as others but my teacher has a way of presenting even the dry and not-easy-to-grasp topics with confidence because she knows science very well. (3)

No, my teacher is very certain about what she is teaching. She has a presence in the room. She thinks that everything she teaches will definitely be on the Regents examination. (26)

One of the students who didn't completely agree that their teacher is not uncertain had this to say:

Sometimes my teacher seems a little bit uncertain about certain aspect of the work or she just wants to pick my brain because I have noticed that teachers pick students brain sometimes. (36)

4.5.5.2 Dissatisfied (Scale Mean 2.08)

This scale assesses the extent to which the teacher expresses dissatisfaction, looks unhappy, criticizes and waits for silence. The scale mean of 2.08 is reflected in the students' interview responses. Almost all the students agreed that their teacher is not dissatisfied with being a teacher, but that she is dissatisfied with opposing and disruptive student behavior. The low scale mean suggests that the teachers are not dissatisfied. Because dissatisfaction has a negative connotation in the interpersonal model a low score represents a positive classroom environment. Students responded to:

Does your teacher express dissatisfaction or look unhappy with her teaching?

No, my teacher is passionately involved with her teaching. She seems very happy with her profession. The way she cares about her students' success makes it clear that she is in the right profession. (6)

No, my teacher is not dissatisfied. She is happy with her profession and really cares about her students. She is only dissatisfied with laziness, which is not tolerated in her classroom whether students like it or not. This is one class where you must work hard. (7)

It seems my teacher is not dissatisfied at being a teacher, but she seems dissatisfied with a few students who show bad behavior and try to disrupt the teaching and learning process. (16)

4.5.5.3 Admonishing (Scale Mean 2.30)

This scale focuses on the extent to which the teacher gets angry, expresses irritation and anger, forbids and punishes. Some of the students stated that their teacher does not show admonishing behavior. Others said that their teacher admonishes because, without it, some students will not follow rules and procedures or do their work. This group of students also believes that admonishing the misbehaving students is necessary so that these students will let others learn. These responses reflect the low scale mean of 2.30 (corresponding to Seldom response). This scale has a negative connotation and its low mean score reflects a positive learning environment. An interesting finding here is that the badly behaved students do not like the consequences that follow their choice of behavior. Students responded to:

Does your teacher get angry unexpectedly or punish students?

No, my teacher doesn't really get mad and yell. She just asks us to do things nicely. But, if you choose not follow the instruction after it has been clarified many times, then you called for whatever you get. Sometimes some of my classmates try not to listen and follow instructions as a way of being defiant or disruptive. (4)

My teacher admonishes sometimes. If you were to be there, you will even commend the teacher for her patience. She first patiently talks to the students and tries in so many ways with the particular student to do the right thing. Ignoring to follow clear instructions is unnecessary if you know that school is for learning and to learn you follow the provided structure. It is not wise to fight being structured and guided as it will only get you in trouble in this class. (6)

Sometimes she doesn't verbalize her admonishing behavior; she just gives you a serious stare that says it all. (9)

No my teacher does not admonish; she does what is necessary to run the class. I think teaching is a tough job, but my classmates don't even care. (38)

4.5.6 QTI Scales with Mean of Approximately 3.00 (Corresponding to the 'Sometimes' Response)

The QTI scales that fell under this category are Student Responsibility/Freedom (mean of 2.73), which has a positive connotation, and Strict (mean of 2.76), which has a negative connotation.

4.5.6.1 Student Responsibility/Freedom (Scale Mean 2.73)

This scale deals with the extent to which the teacher gives opportunity for independent work and gives freedom and responsibility to students. This scale has a positive connotation and should be high for a positive learning environment. Interviews revealed that most of the students thought that they were given more responsibility than freedom. Some of the students expressed that their classmates' behaviors might have contributed to their not having as less freedom and more responsibilities. Some students also expressed that they were given freedom sometimes. This reflects the medium mean score of 2.73 (approximately 3 and corresponds to Sometimes response and supports the construct validity of the scale. Students responded to:

What can you say about your level of responsibility and freedom in this class?
My teacher gives us the responsibility to do our own work all the time. She gives well behaved students more freedom, but I think she should take away more freedom from the students who misbehave because they don't deserve it. I belief there would have been more freedom if all students behave well and can handle it. (14)

There is less freedom compared with responsibilities because some students would act up and abuse the freedom. (16)

We get responsibility and also some freedom when we do things cooperatively. When we do group work, we share responsibilities within the group and we have the freedom to choose how we do our group activities. (18)

We all get responsibilities and you get freedom if you are a well-behaved student who follows the routine of coming in and settling down to work without any push from the teacher. You earn the trust of the teacher and more freedom as well. (21)

The above responses reflect the scale mean of 2.73 which approximately corresponds to the response of Sometimes (3). The students stated that they were given freedom only sometimes.

4.5.6.2 Strict (Scale Mean 2.76)

Strict is one of the QTI scales with a negative connotation and should have a low score for a positive teacher behavior. However, it has been found to correlate positively with achievement in some research in the Netherlands (Wubbels et al., 1991). This scale assesses the extent to which the teacher checks, maintains silence and strictly enforces the rules. The majority of the students thought that their teacher's level of strictness is good for maintaining orders and for the smooth running of their class. Very few thought that their teacher should even be stricter than she is presently. Few thought that their teacher is strict. These responses reflect the scale mean of 2.76 (approximately 3) which corresponds to Sometimes. This further supports the construct validity of the scale. The students clearly understood the wordings and their responses are as intended. The response was to:

Is your science teacher strict?

My teacher is not unnecessarily strict. She gives some leeway but maintains complete control of the class which is very important. (1)

She is strict with enforcing rules with students who are misbehaving and going against the rule. (11)

I think my teacher is not strict enough. She could be a little bit stricter with the students who misbehave in order to keep them quiet. (14)

Yes my teacher is strict but it is because she wants us to cover the curriculum and have some time to review before the Regents examination. She cares so much about the Regents examination. (15)

4.5.7 Interview Results for the TOSRA Scales (Mean around 3 Corresponding to the 'Sometimes' Response)

Students were asked questions in relation to Adoption of Scientific Attitudes (scale mean of 3.37) and Enjoyment of Science Lessons (scale mean of 3.00). Results based on these interviews indicated that the students have a somewhat neutral attitude towards their science classes. Their major complaint was that the teachers chose all the investigations that they do. Also laboratory work is usually conducted under strict conditions. The majority of the students stated that they enjoyed their science classes and also that the strict behaviors exhibited by their science teacher was for good because some of their classmates could not conduct themselves well or follow the safety rules otherwise. Interview questions and sample responses are discussed for Adoption of Scientific Attitudes under subsection 4.5.7.1 and Enjoyment of Science Lessons will be discussed under subsection 4.5.7.2

4.5.7.1 Adoption of Scientific Attitudes (Scale Mean 3.37)

For this attitude scale, students were asked to comment on whether they:

Would like to read things which disagree with their ideas, dislike many trials in an experiment, are curious about the world, view finding new things as important, listen to people with different scientific opinions, like to apply new methods in investigations, and report unexpected findings that might prove their hypothesis wrong.

Some of the students' responses are as follows:

I don't mind having many trials in an experiment as we are taught that this verifies your answer and make it more correct. I like science because it is hand-on and exciting. It baffles me to see that science changes all the time. Because there are always new discoveries, I am more than willingly to try new methods. Also, sometimes when I do an experiment, I find my hypothesis to be wrong and I report it as part of my conclusion. (1)

Negative comments include:

I do not really care so much about science as a person. I am not going to use any of it in future. I am just doing it because my guidance counselor said that it is required that I must do it. I am curious about the world we live in, but not science inclined. As I said before, I hate the subject and hate repeating investigations that don't even appeal to me. It does not matter to me that people have different opinions. I might use new methods in investigation but it doesn't really make any difference to me. (9)

In all the responses from students reflect the neutral scale mean of 3.37.

4.5.7.2 Enjoyment of Science Lessons (Scale Mean 3.00)

This scale assesses whether the students like and enjoy their science lessons. Some of the students reported that they enjoy and look forward to their science lessons. The students who do not like to follow rules or have a structured environment had negative responses. This reflects the scale mean of 3.00 which corresponds to Sometimes on the response scale. For this scale, the students were asked to comment on the following:

Do you like and enjoy your science lessons?

I like my science lessons. They are fun and should be made to be a double period every day. I learn a lot of exciting and interesting things in this class. I don't think it is normal to be bored in this class, except those that have problems with following simple rules and instructions. (18)

Some students made negative comments such as:

The problem I have with my science lessons is that they are done under a very strict and structured environment. If you are asked to view a plant cell under the microscope, that is all you are allowed to do. You cannot, for instance, decide to view a piece of hair or fingernail as this would be considered not using equipment as directed. You get pulled out for playing while you do any experiment or breaking any of the safety rules, many of which do not make any sense to me. The rigidity takes away the fun for me. (10)

4.5.8 Summary of Interviews

A total of 40 students were interviewed by asking them questions pertaining to each scale of the QTI, WIHIC and TOSRA. The main purpose of the interviews was to check the construct validity of the questionnaires. Table 4.7 provides the interview question for each scale of the WIHIC, the QTI and the TOSRA. Questions asked by the researcher were the same for each student and focused on each scale in turn.

Because the central purpose of the interviews was to check the construct validity of the questionnaires, I checked whether the interview comments made by students for each questionnaire scale were consistent with the mean for that scale. If the interview responses were consistent with the scale mean, then the construct validity of the particular scale would be supported. For all questionnaire scales, a scale mean of 1 corresponds to the response alternative of Almost Never, 2 corresponds to Seldom, 3 corresponds to Sometimes, 4 corresponds to Often and 5 corresponds to Almost Always. I used scale means to gauge whether the classroom practices assessed by a

particular scale occurred Seldom, Sometimes, etc. Table 4.8 provides the average item mean for each WIHIC, QTI and TOSRA scale.

The interview data were grouped so that scales with similar scale means were discussed together. The mean for each scale of the questionnaires (WIHIC, QTI, and TOSRA) for the total survey sample of 785 students was provided in the heading of each section. For example, all the WIHIC scales with similar mean scores of 3 were grouped together in the same section for the purposes of reporting and discussion.

Findings from these interviews reinforced the validity of the WIHIC, QTI and TOSRA for use with the sample of high school biology students in New York because the interview findings were mostly consistent with the means obtained for each scale. For example, for the WIHIC scales, the highest mean score was for the scale of Task Orientation (Mean 4.08) and all the students interviewed stressed the importance of finishing their assigned work as this was an important part of their grade. For the WIHIC scale of Investigation with the lowest mean (2.90), students expressed that their teacher chose almost all of the investigations that they carried out. For the QTI scales, Uncertain had the lowest mean score of 2.02, corresponding to the Seldom response. Most of the students said that their teacher was seldom uncertain. Also, for the QTI, students who reported that they perceived their teacher as strict were the same students who scored those teachers high on the Strict scale. This suggests that these instrument are capable of measuring what they intend to measure. Most students reported a neutral opinion about their Adoption of Scientific Attitudes and Enjoyment of Science Lessons, which corresponds to the Sometimes response and a scale mean of 3 for each attitude scale, thereby supporting the construct validity of these attitudes scales.

4.6 CHAPTER SUMMARY

This chapter described the validity and reliability of the 48-item Australian version of the QTI, the 56-item WIHIC and 14-item TOSRA as used in this study. To examine the validity of the WIHIC and TOSRA, factor analyses, internal consistency reliability and discriminant validity for two units of analyses (class mean and individual students) were used. The total amount of variance accounted for by all

scales was 66.05% for the WIHIC and 64.54% for the TOSRA. The mean correlation of a scale with other scale (discriminant validity) ranged from 0.42 (Student Cohesiveness) to 0.53 (Cooperation) for WIHIC scales and was 0.54 for Adoption with the student as the unit of analysis whereas, with class as the unit of analysis, the discriminant validity ranged from 0.51 (Student Cohesiveness) to 0.64 (Cooperation) for WIHIC and 0.68 for Adoption. The QTI was analyzed similarly except that factor and discriminant validity analyses were not undertaken because of the circumplex nature of the instrument.

The Cronbach alpha reliability for WIHIC scales ranged from 0.87 (Student Cohesiveness) to 0.95 (Equity scale) with the student as unit of analysis, and from 0.93 (Task Orientation) to 0.98 (Equity) with the class as the unit of analysis. The Cronbach alpha reliability for the QTI ranged from 0.70 (Student Responsibility/Freedom) to 0.88 (Understanding and Helping/Friendly) with the student as the unit of analysis, and from 0.79 (Strict) to 0.97 (Understanding) with the class as the unit of analysis. The Cronbach alpha reliability for the TOSRA scale of Adoption was 0.80 with the student as the unit of analysis and 0.89 with the class as the unit of analysis and, for the Enjoyment scale, alpha reliability was 0.90 with the student as the unit of analysis and 0.73 with the class as the unit of analysis.

A one-way ANOVA was undertaken for the QTI and the WIHIC. The eta², which is the ratio of 'between' to 'total' sums of squares, and represents the proportion of variance accounted for by class membership, ranged from 0.10 to 0.16 for different WIHIC scales and was statistically significant for each scale. The eta² statistic for QTI scales ranged from 0.13 (Uncertain) to 0.29 (Understanding) and was statistically significant for every scale. This shows that each scale of the WIHIC and QTI could differentiate significantly between classes.

Findings from the interviews showed that Task Orientation had the highest mean score of 4.08. Most of these students were task oriented because they were given marks for participation as part of their achievement grade. Most of the students were likely to be friendly and help and support each other in their science learning activities. Only very few students expressed a different opinion. Most of the students stated that their teacher tries to treat everybody equally, but that it is not always

possible because of disruptive and misbehaving students who have to be checked so that others can learn. The majority of the students in this sample expressed that they cooperate and work and share resources with each other in their science classroom learning activities. Also most of the students were likely to have good relationships with their teachers. The majority of the students perceived their teachers as good leaders, helping, kind, confident and an individual who rarely expressed dissatisfaction and admonishing behaviors (except when necessary with misbehaving and disruptive students). Most students expressed a neutral opinion about the Adoption of Scientific Attitudes and Enjoyment of Science Lessons scales. Findings from this interview reinforced the validity, reliability and usefulness of the WIHIC, QTI and TOSRA for use with a sample of high school biology students in New York as the interview findings were mostly consistent with the scale mean for each scale.

Chapter 5

ASSOCIATIONS BETWEEN THE LEARNING ENVIRONMENT AND STUDENT OUTCOMES

5.1 INTRODUCTION

The previous chapter reported the reliability and validity of the two learning environment instruments (namely, the QTI and the WIHIC) and the attitude scales from TOSRA when used in this research study with a sample of 785 biology students in 75 classes in New York. The main goal of the present study was to investigate associations between student outcomes (attitudes and academic achievement) and two aspects of the learning environment (classroom climate and teacher interpersonal behavior). This chapter is devoted to reporting my investigation of these associations using a series of simple correlation and multiple regression analyses using two units of analysis (student and class). The simple correlation (r) was used to describe the bivariate association between each outcome and each scale of the WIHIC and the QTI questionnaires. Multiple regression analysis was conducted for each attitude scale and achievement to provide information about the joint influence of correlated environment scales on outcomes (attitudes and achievement). The standardized regression coefficient (β) was used as a measure of the association between an outcome and a particular learning environment scale when the effect of the other environment scales is held constant.

The sample size for the attitudinal outcomes was 785 students in 75 classes. For the achievement outcome, the sample size was 603 students in 37 classes. The reasons for the difference in sample sizes, as explained in a previous chapter (Section 3.4), were that some schools did not release their students' biology Regents examination results because of their school district's policy of obtaining parents' permission. This information was relayed to the researcher very late (even though the consent letters sent home to the parents had already explained that these achievement results would be needed). Also the Regents examination was not taken by some of the students who were either absent or did not meet the New York state-mandated requirement of completing 1,200 minutes of laboratory investigations before taking the Regents

examination. The achievement outcome, as mentioned earlier in Sections 1.5, 1.6 and 3.4, was assessed by a state standardized science examination (Regents Living Environment examination). Attitudinal outcomes were measured by two scales of TOSRA (Enjoyment of Science Lessons and Adoption of Scientific Attitudes). The 56-item 7-scale version of the WIHIC was used to assess students' perceptions of their learning environment, while the 48-item 8-scale version of the QTI was used to assess students' perceptions of their teachers' interpersonal behavior.

This chapter is divided into the following sections:

5.2 Associations between WIHIC Scales and Student Outcomes

5.3 Associations between QTI Scales and Student Outcomes

5.4 Commonality Analysis of Unique and Common Variance in Student Outcomes Associated with WIHIC and QTI.

5.2 ASSOCIATIONS BETWEEN WIHIC SCALES AND STUDENT OUTCOMES

This section focuses on associations between WIHIC scales and the student outcomes of achievement and attitudes as presented in Table 5.1. Simple correlations (*r*) were used to indicate the strength of the association between each WIHIC scale and each outcome. Multiple regression analysis was conducted for each outcome measure to provide information about the joint influence of correlated WIHIC scales on outcomes (attitudes and achievement). The standardized regression coefficient (β) was used to describe the association between an outcome and a particular WIHIC scale when the effect of the other WIHIC scales was held constant. All the statistical analyses were conducted for two units of analysis, namely, the individual student and the class mean. Associations between WIHIC scales and students' attitudes are reported in detail in Section 5.2.1, whereas Section 5.2.2 focuses on associations between WIHIC scales and students' achievement.

Table 5.1 Simple Correlation and Multiple Regression Analyses for Associations Between Student Outcomes and WIHIC Scales for Two Units of Analysis

Scale	Unit of Analysis	Outcome-Environment Association					
		Enjoyment		Adoption		Achievement	
		r	β	*r*	β	*r*	β
Student Cohesiveness	Student	0.12**	-0.18**	0.31**	-0.06	0.07*	0.06
	Class	0.40**	-0.37*	0.49**	-0.05	0.30*	0.52
Teacher Support	Student	0.47**	0.24**	0.43**	-0.03	0.02	-0.13*
	Class	0.73**	0.80**	0.82**	0.59**	-0.02	0.32
Involvement	Student	0.43**	0.22**	0.48**	0.14**	0.07*	0.07
	Class	0.55**	-0.02	0.76**	-0.06	-0.10	-0.83
Investigation	Student	0.39**	0.09*	0.51**	0.23**	0.06	0.02
	Class	0.53**	0.16	0.78**	0.31*	0.01	0.25
Task Orientation	Student	0.30**	0.08*	0.47**	0.18**	0.10**	0.10
	Class	0.42**	0.13	0.67**	0.15	0.17	-0.16
Cooperation	Student	0.29**	0.03	0.49**	0.17**	0.03	-0.12
	Class	0.30*	0.04	0.70**	0.33*	0.22	0.17
Equity	Student	0.37**	0.10*	0.48**	0.17**	0.10**	0.13*
	Class	0.48**	-0.15	0.66**	-0.25	0.12	-0.08
Multiple Correlation, *R*	Student		0.54**		0.63**		0.17*
	Class		0.80**		0.90**		0.48

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

The sample consisted of 785 students in 75 classes for the attitude scales, and 603 students in 37 classes for achievement.

5.2.1 Associations between WIHIC Scales and Student Attitudes

Table 5.1 shows the results for the associations between the WIHIC scales and the two attitude scales used in this study. Simple correlation analysis revealed that all the seven WIHIC scales were significantly correlated with attitudes to science. For Enjoyment, correlations ranged from 0.12 (Student Cohesiveness) to 0.47 (Teacher Support) with the student as the unit of analysis, and from 0.30 (Cooperation) to 0.73 (Teacher Support) with the class as unit of analysis. These numbers indicate that students enjoyed their science lessons more when they perceived their teacher as being supportive. For Adoption of Scientific Attitudes, correlations ranged from 0.31 (Student Cohesiveness) to 0.51 (Investigation) with the student as the unit of analysis, and from 0.49 (Student Cohesiveness) to 0.82 (Teacher Support) with the class as the unit of analysis. This again indicates that students adopted more favorable scientific attitudes when they perceived their science teacher as being supportive. The correlations between both Enjoyment and Adoption and every WIHIC scale were

statistically significant and were positive for both units of analysis. The closer to one the numbers are, the stronger the correlations.

Multiple regression analysis provides information about the multivariate association between an attitude scale and the set of seven WIHIC scales. The multiple correlation for the set of WIHIC scales was 0.54 for Enjoyment and 0.63 for Adoption with the individual student as unit of analysis, and was 0.80 for Enjoyment of Science Lessons and 0.90 for Adoption of Science Attitudes with the class as the unit of analysis. These multiple correlations were all statistically significant at each level of analysis.

The standardized regression coefficients (β) were used to identify the environment scales which contributed uniquely and significantly to the explanation of the variance in the attitudes scales. Beta weights revealed that: all WIHIC scales except Cooperation were significantly and independently associated with student Enjoyment with the individual student as the unit of analysis. However, Student Cohesiveness was negatively associated with the Enjoyment scale with the student as the unit of analysis. With the class as the unit of analysis, only Student Cohesiveness (negatively) and Teacher Support (positively) were significantly and independently associated with Enjoyment.

Involvement, Investigation, Task Orientation, Cooperation and Equity were each significantly and independently related to Adoption of Scientific Attitudes with the student as the unit of analysis. With the class as the unit of analysis, Teacher Support, Investigation and Cooperation were significantly and independently associated with Adoption. All of these significant associations were positive, suggesting that students adopt a positive attitude to science in classrooms where they perceive students to be involved, carry out investigations, be on task, cooperate and work with each other, and where their teachers treat every student equitably. With the class as the unit of analysis, the findings suggest that a learning environment where teachers are perceived as being supportive, and where students are involved in investigations and cooperate with each other is associated with a more positive attitude to science among students.

The finding that Student Cohesiveness was negatively and independently associated with Enjoyment with both individual student and class as unit of analysis was further explored through student interviews as reported in more detail in Chapter 4. Briefly stated, interview findings suggested that some students were distracted by very talkative and overly social students. These distractions reduced their enjoyment of the science lessons as they missed some vital information here and there during the ongoing distracting behavior of their peers. For the most part, positive relationships existed between student outcomes and the learning environment, thus confirming that students' perceptions of their classroom environment are important in terms of students' attitudes.

5.2.2 Associations between WIHIC Scales and Student Achievement

Table 5.1 shows the results for the associations between WIHIC scales and student achievement. Simple correlation analysis revealed that there was a significant correlation between achievement and four of the WIHIC scales of Task Orientation, Equity, Student Cohesiveness and Involvement with the student as the unit of analysis. With the class as the unit of analysis, only Student Cohesiveness was significantly correlated with achievement.

Multiple regression analysis provides information about associations between each scale of the WIHIC and students' achievement as measured by a state standardized test. The multiple correlation *(R*) was 0.17 with the student as the unit of analysis and was statistically significant ($p<0.05$) and was 0.48 with the class as the unit of analysis and was not statistically significant (Table 5.1).

The standardized regression coefficients (β) were used to identify which WIHIC scales contributed uniquely and significantly to the explanation of the variance in achievement. Beta weights revealed that two of the WIHIC scales (Teacher Support and Equity) were significantly and independently associated with achievement with the student as the unit of analysis. With the class as the unit of analysis, none of the WIHIC scales was significantly and independently associated with achievement.

Teacher Support was negatively, significantly and independently associated with achievement, while Equity was positively, significantly and independently associated with achievement with the student as the unit of analysis. Consequently, where students perceived that the class operated equitably, students achieved better in their Regents science examination. A possible explanation of Teacher Support being negatively associated with achievement could be that academically-weaker students were given extra support by the teacher relative to the others. This suggests that the quality of the classroom environment is important for students' achievement.

5.3 ASSOCIATIONS BETWEEN QTI SCALES AND STUDENT OUTCOMES

As with the WIHIC, simple correlations and multiple regression analyses were carried out to determine associations between the student outcomes of attitudes and academic achievement and QTI scales. Table 5.2 provides the results for the outcomes of Enjoyment of Science Lessons, Adoption of Scientific Attitude and achievement in Regents biology examination for two units of analysis (the student and the class). Associations between the QTI and students' attitude are reported in detail in Section 5.3.1 whereas Section 5.3.2 focuses on associations between QTI scales and students' achievement.

The first four QTI scales (Leadership, Understanding, Helping/Friendly and Student Responsibility/Freedom) have a positive connotation, whereas the other four QTI scales (Uncertain, Admonishing, Dissatisfied and Strict) have a negative connotation. Therefore, for a favorable environment, scores would be higher on the first four QTI scales and lower for the second four QTI scales. Thus, for a more favorable environment to be linked to higher outcome scores, relationships in Table 5.2 would be expected to be positive in the first four QTI scales and negative for the other four QTI scales.

Table 5.2 Simple Correlation and Multiple Regression Analyses for Associations Between Student Outcomes and QTI Scales for Two Units of Analysis

Scale	Unit of Analysis	Outcome-Environment Association					
		Enjoyment		Adoption		Achievement	
		r	β	*r*	β	*r*	β
Leadership	Student	0.46**	0.30**	0.44**	0.14*	0.12**	-0.03
	Class	0.76**	0.56	0.76**	0.11	0.28*	-0.18
Understanding	Student	0.46**	0.16*	0.46**	0.30**	0.12**	0.00
	Class	0.78**	0.28	0.80**	0.43	0.26*	-0.51
Helping/Friendly	Student	0.44**	0.14*	0.42**	0.12	0.14**	0.08
	Class	-0.10	0.19	0.79**	0.32	0.30*	0.11
Student Responsibility/ Freedom	Student	0.30**	0.06	0.22**	0.03	-0.01	0.05
	Class	-0.51**	-0.19	0.45**	-0.06	0.10	0.65
Uncertain	Student	0.04	0.24**	-0.07*	0.05	0.14**	-0.21**
	Class	0.76**	0.51**	-0.39**	0.10	-0.42**	-0.48
Admonishing	Student	-0.10**	-0.10	-0.10**	0.02	-0.01	0.07
	Class	0.58**	-0.27	-0.59**	0.09	-0.36*	-0.14
Dissatisfied	Student	-0.07*	0.12*	-0.10**	0.05	-0.16**	-0.07
	Class	-0.34*	0.19	0.58**	-0.20	-0.43**	-0.47
Strict	Student	-0.05	-0.07	-0.01	0.05	-0.09**	0.03
	Class	-0.40**	-0.11	0.37**	0.05	0.04	0.34
Multiple Correlation, *R*	Student		0.55**		0.50**		0.21**
	Class		0.87**		0.81**		0.62

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

The sample consisted of 785 students in 75 classes for the attitude scales, and 603 students in 37 classes for achievement

5.3.1 Associations between the QTI Scales and Student Attitudes

As mentioned earlier, associations between the QTI scales and student attitudinal outcomes were analyzed using simple correlations and multiple regression. An examination of the simple correlation coefficients in Table 5.2 indicates that there were statistically significant correlations between six of the QTI scales and Enjoyment with the individual student as the unit of analysis. With class as the unit of analysis, seven out of eight QTI scales were significantly correlated with Enjoyment. With the student as the unit of analysis, four QTI scales with a positive connotation (Leadership, Understanding, Helping/Friendly and Student Responsibility/Freedom) were positively and significantly correlated with Enjoyment, whereas two of the four QTI scales with a negative connotation (Admonishing and Dissatisfied) were negatively and significantly correlated with Enjoyment.

With class as the unit of analysis, positive and significant correlations were found between Enjoyment and two of the four QTI scales with a positive connotation (Leadership and Understanding), and also with two of the four QTI scales with a negative connotation (Uncertain and Admonishing). Negative and significant correlations were found between Enjoyment and Student Responsibility/Freedom (which has a positive connotation) and two QTI scales with a negative connotation (Dissatisfied and Strict). There were some anomalies with the findings for these associations. Student Responsibility/Freedom, which has positive connotation, was negatively correlated with Enjoyment with class as the unit of analysis. As suggested during interviews, this could be because most of the students expressed that they were given more responsibilities than freedom. Also some of their classmates could not handle whatever freedom was given because they usually could not behave themselves and stay focused and on task. Uncertain was also positively correlated with Enjoyment with class as the unit of analysis, but findings from interviews suggested that the students did not perceive their science teachers as uncertain. Also Admonishing was found to be positively correlated with Enjoyment with class as the unit of analysis, perhaps because most of the students in this study viewed Admonishing teacher behavior as a good way to manage badly-behaved students so that the rest of the class could enjoy their science lessons. They associated Admonishing behavior with maintaining an orderly and structured environment that is conducive to learning**.**

Table 5.2 shows that, with the student as the unit of analysis, the Adoption scale was positively and statistically significantly correlated with the four QTI scales with positive connotation (Leadership, Understanding, Helping/Friendly and Student Responsibility/Freedom) and negatively and significantly correlated with three of the four QTI scales with negative connotation (Uncertain, Admonishing and Dissatisfied). That is, all of these significant correlations were in the anticipated direction.

With class as the unit of analysis, the Adoption of Scientific Attitudes scale had significant and positive associations with the three QTI scales of Leadership, Helping/Friendly, Student Responsibility/Freedom, each of which has a positive connotation, and with two QTI scales with a negative connotation (Dissatisfied and Strict). However, the Adoption scale also had a negative and significant association

with the Uncertain and Admonishing scales (both scales have negative connotations). Anomalies were found with the two QTI scales of Dissatisfied and Strict which were positively associated with Adoption of Scientific Attitudes with the class as the unit of analysis. Interviews gave an important insight into why this happened. Students reported that they adopt better attitudes when they perceive that their teachers are dissatisfied with their behaviors, mainly because their classroom participation and behavior influence their grades. Also Strict teacher behavior was accepted by the majority of the students interviewed as an important method of controlling the class and providing a structured learning environment.

The multiple correlations between an attitude scale (Enjoyment or Adoption) and QTI scales were 0.55 (student as the unit of analysis) and 0.87 (class as the unit of analysis) for Enjoyment of Science Lessons and 0.50 (student as the unit of analysis) and 0.81 (class as the unit of analysis) for Adoption of Scientific Attitudes. Each of these multiple correlation was statistically significant. These results suggest a relatively strong association between an attitude scale (Enjoyment or Adoption) and QTI scales which measures teachers' interpersonal behavior.

An examination of beta weights revealed that Leadership, Understanding, Helping/Friendly, Uncertain, and Dissatisfied scales were positively and independently associated with Enjoyment of Science Lessons with the student as unit of analysis whereas, with the class as unit of analysis, only the QTI scale of Uncertain was positively and independently associated with Enjoyment.

The Adoption of Scientific Attitudes was positively and independently associated with the QTI scales of Leadership and Understanding with the student as the unit of analysis. This suggests that students displayed a more favorable attitude where they perceived their teachers to display Leadership and Understanding behavior. These results are somewhat different from past research in that Uncertain and Dissatisfied teacher behaviors were independently and positively associated with Enjoyment. Possible reasons for these anomalies were already explained earlier in this section.

For the two attitude scales, there were both positive and negative correlations with QTI scales. Adoption of Scientific Attitudes was negatively correlated with Uncertain,

Admonishing and Dissatisfied teacher behavior with the student as the unit of analysis, and was negatively correlated with Uncertain and Admonishing teacher behavior with the class as the unit of analysis. With the student as the unit of analysis, Enjoyment was negatively correlated with Admonishing and Dissatisfied teacher behaviors. With the class as the unit of analysis, Enjoyment of Science Lessons was negatively correlated with Student Responsibility/Freedom, Dissatisfied and Strict scales of the QTI. For Enjoyment, therefore, the observed correlations are as expected (positive associations and higher attitude scores for the first four QTI scale of Leadership, Understanding, Helping/Friendly and Student Responsibility/Freedom, which have positive connotations, and negative or no associations and lower attitude scores for the last four QTI scales of Uncertain, Admonishing, Dissatisfied and Strict, which have negative connotations) with the student as the unit of analysis. With the class as the unit of analysis, there were two anomalies in that the QTI scales of Student Responsibility/Freedom and Admonishing have relationships with Enjoyment which were not in the expected direction. For the Adoption scale, there were positive associations and higher attitude scores for the first four QTI scales of Leadership, Understanding, Helping/Friendly and Student Responsibility/Freedom, which have a positive connotation, and negative associations and lower attitude scores for the last four QTI scales as expected with the student as the unit of analysis. With the class as the unit of analysis, there were two anomalies in that associations were not in the expected directions for the Adoption scale and the QTI scales of Dissatisfied and Strict. These findings with student as the unit of analysis are similar to those in past research (Brekelmans, Wubbels, & Levy, 1993; Kim et al., 2000; Scott & Fisher, 2004).

This suggests that students had more favorable attitudes towards science where they perceived their teacher as showing leadership and being understanding and helping/ friendly.

5.3.2 Associations between QTI Scales and Student Achievement

Simple correlation and multiple regression analyses were carried out to investigate associations between QTI scales and student academic achievement (measured by

New York state Regents biology examination). These results are summarized in Table 5.2 for two units of analysis (student and class). Simple correlations revealed that six out of eight scales of the QTI were significantly associated with student achievement with the student as unit of analysis. Three of the QTI scales with a positive connotation, namely, Leadership, Understanding, Helping/Friendly, and one of the QTI scales with a negative connotation Uncertain were positively correlated with achievement. As expected from the model of Interpersonal Behavior in Figure 2.1, the two scales of Dissatisfied and Strict were negatively correlated with student achievement with the student as the unit of analysis. However, it is noteworthy that a positive a positive association between Strict and achievement has been reported for research in the Netherlands (Wubbels et al., 1991).

With the class as the unit of analysis, the six QTI scales of Leadership, Understanding, Helping/Friendly, Uncertain, Admonishing and Dissatisfied showed significant associations with student achievement. Helping/Friendly, Leadership, and Understanding were positively correlated with achievement, whereas Dissatisfied, Uncertain and Admonishing were negatively correlated with students' achievement with the class as the unit of analysis. As expected, positive associations existed between QTI scales with a positive connotation and achievement, whereas a negative association existed between QTI scales with a negative connotation and achievement.

The bottom of Table 5.2 shows that the multiple correlation (R) was 0.21 with the student as the unit of analysis and statistically significant. With the class as the unit of analysis, the multiple correlation was 0.62 but was not statistically significant. The beta weights revealed that Uncertain behavior was the only QTI scale that was negatively, independently and significantly associated with achievement with the student as the unit of analysis.

This suggests that students' achievement, as measured by the standardized state test, is higher in classes where students perceive their teacher as being helping/friendly, a good leader and understanding. Also, the more cooperative and the less uncertain that teachers were, the better the student achievement.

5.4 COMMONALITY ANALYSIS OF UNIQUE AND COMMON VARIANCE IN STUDENT OUTCOMES ASSOCIATED WITH WIHIC AND QTI

Section 5.2 dealt with associations between WIHIC scales and the student outcomes of achievement and attitudes, while Section 5.3 described associations between QTI scales and the same student outcomes of achievement and attitudes. In contrast, the present section reports commonality analyses (Cooley & Lohnes, 1976; Goh & Fraser, 1998; Fraser et al., 1995; Pedhazur, 1982) that were carried out in order to address my fourth research objective concerning the magnitude of the unique and joint contributions of WIHIC and QTI in explaining variance in the student outcomes of achievement and attitude. This section, therefore, focuses on the magnitude of the amounts of unique and common variance in student outcomes explained by the QTI and the WIHIC. The main purpose of conducting this analysis was to investigate whether it was useful to include the WIHIC and the QTI in the same study of student outcomes.

Goh and Fraser (1998), in their study of teacher interpersonal behavior, classroom environment and students' outcomes in primary mathematics in Singapore, conducted commonality analyses. These were undertaken in order to examine the magnitude of the amounts of variance in student outcomes explained jointly and uniquely by two learning environment instruments, namely, the My Class Inventory (MCI) and the QTI. They found that including both the QTI and MCI in studying attitudinal outcomes was useful whereas, for achievement outcomes, there was no additional advantage. Similarly, in my study, I conducted commonality analysis of unique and common variance in student outcomes associated with the WIHIC and QTI.

Data were based on the same sample of 785 students in 75 classes for attitudinal outcomes and 603 students in 37 classes for achievement. Commonality analyses were undertaken in order to examine the unique and joint contributions of classroom learning environment (assessed by WIHIC) and interpersonal teacher behavior (assessed by QTI) in explaining variance for three student outcomes of Enjoyment of Science Lessons, Adoption of Scientific Attitudes, and Achievement. The unique variance in this context was the variance in an outcome (Enjoyment, Adoption or Achievement) attributable to either the WIHIC or the QTI other than that attributable

to the other instrument. The commonality is variance in student outcomes contributed jointly by interpersonal teacher behavior and classroom learning environment.

Table 5.3 reports the results of commonality analyses that were conducted using the square of multiple correlation (R^2) to examine the unique and joint contributions of WIHIC and QTI in explaining variance in each of the three student outcomes. A separate commonality analysis was conducted for each outcome (Enjoyment, Adoption and Achievement) with the student as the unit of analysis.

For Enjoyment, the WIHIC made a unique contribution to variance of 0.07 beyond that contributed by the QTI (Table 5.3). The QTI made a unique contribution to variance in Enjoyment scores of 0.18 beyond that attributable to the WIHIC. The common contribution of the WIHIC and QTI to variance in Enjoyment scores was 0.12 and relatively large. This finding suggests that, whilst each instrument made somewhat overlapping contributions to the variance in student Enjoyment of Science Lessons, each instrument also made a unique contribution. The benefit of using both instruments when investigating Enjoyment is supported by this finding. Therefore, it is worthwhile to include both the WIHIC and QTI in the same study of students' enjoyment of science.

For Adoption, the WIHIC made a unique contribution to variance of 0.08 beyond that contributed by the QTI (Table 5.3). The QTI's contribution to variance in Adoption scores was only 0.03 beyond that attributable to the WIHIC. The common contribution of the WIHIC and QTI to variance in Adoption scores was 0.21. Overall, the results in Table 5.3 suggest that it is not useful to include both the WIHIC and QTI within the same study of students' Adoption of Scientific Attitudes.

For the Achievement outcome, the WIHIC made a unique contribution to variance of 0.02 beyond that contributed by the QTI. The QTI made a unique contribution to variance in achievement score of 0.04 beyond that attributable to the WIHIC. The common contribution of the WIHIC and QTI to variance in achievement score was 0.01 and low. In terms of achievement scores, neither WIHIC nor QTI accounted for much unique or common variance in achievement.

An interesting finding here was that both the WIHIC and the QTI contributed more to the variance in attitudinal outcomes than to the variance in the achievement outcome.

Table 5.3. Commonality Analysis of R^2 Statistic for WIHIC and QTI for Three Student Outcomes (Enjoyment, Adoption and Achievement)

Component	R^2		
	Enjoyment	Adoption	Achievement
Unique to WIHIC	0.07	0.08	0.02
Unique to QTI	0.18	0.03	0.04
Commonality	0.12	0.21	0.01
Total	0.37	0.32	0.07

N = 785 for attitude measures and 603 for achievement

The WIHIC and the QTI each made a sizeable unique contribution to the prediction of students' enjoyment of science lessons. Whilst each instrument makes somewhat overlapping contributions to the variance in student enjoyment, each instrument also makes a unique contribution. Therefore, the use of two instruments together is likely to enhance the prediction of student enjoyment scores. However, the present study also suggested that there is no point including both the WIHIC and QTI in a study of Adoption of Scientific Attitudes. Also, neither the WIHIC nor the QTI accounted for much unique or common variance in achievement.

These findings are somewhat similar to those of Goh and Fraser (1998). In their study of teacher interpersonal behavior, classroom environment and students outcomes in primary mathematics in Singapore, including both the QTI and MCI in the same study of Liking for Mathematics was useful. However, for an achievement outcome, they found that there was little benefit in including both the QTI and MCI in the same study.

5.5 CHAPTER SUMMARY

This chapter was devoted to addressing my research objectives two, three and four which were to:

2. Investigate associations between the classroom learning environment and students':

a. Science achievement
b. Attitudes to science

3. Investigate associations between teacher interpersonal behavior and students':
    a. Science achievement
    b. Attitudes to science
4. Investigate the magnitude of the unique and common contributions of the WIHIC and QTI in explaining variance in students':
    a. Science achievement
    b. Attitudes to science.

Simple correlation and multiple regression analyses were conducted for two units of analysis (student and class) to investigate associations between QTI scales (teachers' interpersonal behavior) and student outcomes, as well as between WIHIC scales (learning environment) and student outcomes to address my second and third research objectives stated above.

The simple correlations between the two attitude scales (Enjoyment and Adoption) and the WIHIC scales were statistically significant and positive for all WIHIC scales at both the student and class levels of analysis. The multiple correlation for Enjoyment was 0.54 at the student level of analysis and 0.80 at the class level and was statistically significant in both cases. Also, the multiple correlation was statistically significant between WIHIC scales and Adoption at both the student and class levels of analysis (0.63 and 0.90, respectively).

An inspection of beta weights revealed that, with the student as the unit of analysis, all WIHIC scales except Cooperation were significantly and independently associated with student Enjoyment. With the class as the unit of analysis, only Student Cohesiveness and Teacher Support were significantly and independently associated with Enjoyment.

All WIHIC scales except Student Cohesiveness and Teacher Support were significantly and independently related to Adoption of Scientific Attitudes with the student as the unit of analysis. With the class as the unit of analysis, Teacher Support,

Investigation and Cooperation were significantly and independently associated with Adoption.

At the student level, simple correlations were significant and positive between four of the WIHIC scales (Student Cohesiveness, Involvement, Task Orientation and Equity) and achievement. Two of the seven WIHIC scales (Teacher Support and Equity) were significantly and independently associated with achievement with the student as the unit of analysis.

Thus students' perceptions of their classroom environment are important for both students' attitudes and achievement. This replicates past research (Fraser, 1998a; Lee, Fisher & Fraser, 2003; Fisher, Henderson & Fraser, 1995; Kim, Fisher & Fraser, 2000; Koul & Fisher, 2005; Chionh & Fraser, 2009).

My second research objective focused on associations between teacher interpersonal behavior and students' science achievement and attitudes to science. Simple correlations revealed that six out of the eight scales of the QTI (Leadership, Understanding, Helping/Friendly, Uncertain, Dissatisfied and Strict) were significantly associated with student achievement at the student level of analysis. At the class level, six of the QTI scales (Leadership, Understanding, Helping/Friendly, Uncertain, Admonishing and Dissatisfied) were also significantly associated with achievement. These statistically significant correlations between the QTI scales (which assess teachers' interpersonal behavior) and achievement were positive for the first three QTI scales at both the student and class levels as expected. Unexpectedly, there was a positive correlation between Uncertain and students' achievement at the student level. However, beta weights revealed that the Uncertain scale was not only negatively, significantly and independently associated with achievement at the student level, but it was also the only significant independent predictor of students' Living Environment (Biology) Regents grades. The simple correlation was significant and negative at the class level only between achievement and QTI scales of Uncertain and Admonishing. Simple correlations between achievement and Dissatisfied were negative at both the student and class levels of analysis whereas, for Strict, there was a negative correlation with achievement only at the student level. These negative

correlations were all in the expected directions as these scales (Uncertain, Admonishing, Dissatisfied and Strict) all have negative connotations.

For the attitude scales at the student level of analysis, the Leadership and Understanding scales were significantly and independently associated with Adoption of Scientific Attitudes. Also Leadership, Understanding, Helping/Friendly, Uncertain and Dissatisfied scales were each significantly and independently associated with the Enjoyment of Science Lessons. The Uncertain scale was also the only significant independent predictor of Enjoyment at the class level of analysis.

Generally, I found stronger outcome-environment associations for attitudes than for achievement. This finding is consistent with results from past research (Fraser, Giddings & McRobbie, 1995; Talton & Simpson, 1987; Lightburn & Fraser, 2007; Witisiri & Fisher, 2007). Research suggest that teachers should be increasingly made aware of the important role that classroom environment might play in the formation of students' attitudes toward science, as well as in the achievement. This could possibly substantially increase student interest and achievement in science.

Commonality analyses were undertaken in order to examine the unique and joint contributions of classroom learning environment (assessed by WIHIC) and interpersonal teacher behavior (assessed by QTI) in explaining variance for three student outcomes of Enjoyment, Adoption, and Achievement. This addressed my fourth research objective. The WIHIC and the QTI each made a sizeable unique contribution to the prediction of students' enjoyment of science lessons. Whilst each instrument made somewhat overlapping contributions to the variance in student enjoyment, each instrument also made a unique contribution. Therefore the use of the two instruments together in future research is likely to enhance the prediction of student enjoyment. However, the present study also suggested that there is no point including both the WIHIC and QTI in a study of Adoption of Scientific Attitudes. Also, neither the WIHIC nor the QTI accounted for much unique or common variance in achievement.

The results from the present research have important implications for classroom practice. For example, science teachers wishing to enhance students' cognitive

achievement should strive to display less Uncertain, Admonishing, Dissatisfied, and Strict behaviors, as well as more Leadership, Helping/Friendly, and Understanding behaviors. Also, the finding of statistically significant and positive simple correlations between all of the WIHIC scales (Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity) and the two attitudes scales (Enjoyment and Adoption) suggests that a positive classroom learning environment can promote more positive attitudes to science among students.

Chapter 6

CONCLUSIONS

6.1 INTRODUCTION

This chapter deals with conclusions and implications for my study of associations between teachers' interpersonal behavior, classroom learning environment and students' outcomes among 785 biology students from 75 classes in New York. Because this study is one of the first that investigated these associations with a sample of secondary school biology students in New York, it made a distinctive contribution to the field of learning environment.

This final chapter is organized using the following sections:

- Summary of chapters 1–3 (Section 6.2),
- Major findings for the research questions (Section 6.3),
- Implications of findings (Section 6.4),
- Constraints and limitations (Section 6.5),
- Recommendations for further research (Section 6.6), and
- Summary and concluding remarks (Section 6.7).

6.2 SUMMARY OF CHAPTERS 1–3

Chapter 1 introduced the study by summarizing its background, theoretical framework (especially the field of learning environment), significance, limitations, and methodology, as well as providing an overview of the study, the various chapters of the thesis, and its aims and objectives, which were to:

1. Cross-validate the QTI, the WIHIC and the TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with a New York sample,
2. Investigate associations between the classroom learning environment and students':

a. Science achievement
b. Attitudes to science

3. Investigate associations between teacher interpersonal behavior and students':
    a. Science achievement
    b. Attitudes to science
4. Investigate the magnitude of the unique and common contributions of the WIHIC and QTI in explaining variance in students':
    a. Science achievement
    b. Attitudes to science.

Chapter 2 presented a review of pertinent literature from the field of learning environment relevant to my study, including pioneering research in the field, development of learning environment instruments, especially the Questionnaire on Teacher Interaction (QTI) and the What Is Happening In this Class? (WIHIC) that were used in this study. A review of past studies involving the validation and use of the WIHIC was presented in this chapter. Similarly, a review of literature pertaining to past use and validation of the QTI and a measure of students' attitudes (TOSRA) was also presented.

Chapter 3 provided procedural information about the research design, selection and description of the sample, instrumentation, data collection, data entry and data analysis. In addition, difficulties encountered during data collection were described. The quantitative data were collected by using a 56-item 7-scale version of the WIHIC, a 48-item 8-scale version of the QTI, two scales of the TOSRA (Enjoyment of Science Lessons and Adoption of Scientific Attitudes), and an achievement measure derived from the Regents biology examination. 785 students from 75 classes responded to the questionnaire, whereas achievement scores were gathered for only 603 students in 37 classes. The reasons for the difference in sample sizes, as explained previously in Sections 3.4 and 5.1, were that some schools did not release their students' Regents biology examination results because of their school district's policy of obtaining parents' permission, and because the Regents examination was not taken by some of the students who were either absent or did not meet the New York state mandated requirement of completing 1,200 minutes of laboratory investigations before taking this examination. The qualitative data were obtained from interviews

with 40 students using questions pertaining to each scale of the QTI, WIHIC and TOSRA. The interviews were conducted in order to support the construct validity of the questionnaires by checking consistency between scale means and students' interview comments.

Chapter 4 reported results for my study's first research objective involving cross-validation of the QTI, the WIHIC and the TOSRA when used with a New York sample. Factor analyses and discriminant validity for the WIHIC and TOSRA, as well as internal consistency reliability for all three instruments, were reported. The ability to differentiate between classes (ANOVA) was reported for QTI and WIHIC scales. Validity information regarding the QTI was also obtained from the scale intercorrelation matrix. In addition, qualitative findings from interviews were used in supporting the validity of the QTI and the WIHIC.

Chapter 5 reported associations between students' perceptions of teachers' interpersonal behavior, learning environment and the student outcomes of attitudes and achievement. The two methods of data analysis used were simple correlation and multiple regression. Standardized regression coefficients (β) were used to identify the environment scales which contributed uniquely and significantly to the explanation of the variance in student outcomes. In addition, commonality analyses were conducted to examine the magnitude of the variance in student outcomes explained uniquely and jointly by interpersonal teacher behavior (QTI) and classroom learning environment (WIHIC).

6.3 MAJOR FINDINGS FOR THE RESEARCH QUESTIONS

The major findings for each of the research objectives of my study are summarized in this section.

Research objective 1:

To cross-validate the QTI, the WIHIC and the TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with a New York sample.

Results from the study presented in Chapters 4 and 5 show that the QTI, the WIHIC and the TOSRA were valid and reliable instruments when used with secondary school biology classes in New York (USA).

To determine the factorial validity of the WIHIC questionnaire and the TOSRA, principal axis factor analysis followed by varimax rotation and Kaiser normalization were conducted. Faulty questionnaire items whose removal improved the internal consistency reliability and factorial validity of the instrument were identified by this process. The criteria for the retention of any item during the factor analysis were that its factor loading must be at least 0.40 on its own scale and less than 0.40 on all other scales of the instrument. The application of these criteria led to the removal of Items 6 and 8 from Student Cohesiveness scale of the WIHIC, as well as Items 58 and 60 from the Adoption of Scientific Attitudes scale and Items 65 and 67 from the Enjoyment of Science Lessons scale of the TOSRA. The WIHIC (Table 4.1) had a satisfactory factorial validity, with the a priori seven-scale structure being supported. The total percentage of variance explained was 66.05% for the WIHIC. The eigenvalues ranged between 1.55 and 19.99 for different WIHIC scales. The TOSRA also displayed satisfactory factor loadings. The percentage of variance explained for Adoption was 15.00% and for Enjoyment was 49.54%, with the total being 64.54%. The eigenvalue was 1.50 for Adoption and 4.95 for Enjoyment. These factor analyses support the factorial validity of the WIHIC and TOSRA when used with students in New York.

To check the degree to which items in the same scale were measuring the same aspect of teacher-student interpersonal behavior (QTI), learning environment (WIHIC), and attitudes (TOSRA), the alpha reliability coefficient (Cronbach, 1951) was used as an index of internal consistency. With the student as the unit of analysis for the WIHIC questionnaire (Table 4.2), the highest alpha reliability was 0.95 (Equity) and the lowest was 0.87 (Student Cohesiveness) whereas, with the class as the unit of analysis, the highest alpha reliability was 0.98 (Equity) and lowest was 0.93 (Task Orientation). For the QTI scales (Table 4.3), the alpha reliability ranged from 0.74 (Student Responsibility/Freedom) to 0.88 (Understanding and Helping/Friendly) with the student as unit of analysis, and from 0.79 (Strict) to 0.97 (Understanding) for class means. For the two TOSRA scales (Table 4.5), the alpha reliability for the Adoption

scale was 0.80 with the student as the unit of analysis and 0.89 for class means. The alpha reliability for the Enjoyment scale was 0.90 with the student as the unit of analysis and 0.73 for class means. Therefore the internal consistency reliability was satisfactory for every WIHIC, QTI and TOSRA scale for my sample of 785 students in 75 classes.

The mean correlation of one scale with other scales (discriminant validity) for the WIHIC (Table 4.2) ranged from 0.42 (Student Cohesiveness) to 0.53 (Cooperation) with the student as unit of analysis and from 0.51 (Student Cohesiveness) to 0.64 (Cooperation) with the class as unit of analysis. For the TOSRA (Table 4.5), the correlation between the two scales was 0.54 for students and 0.68 for classes. These values are small enough to suggest that raw score on each scale of the WIHIC and the TOSRA have adequate discriminant validity, although they overlap somewhat. But the factor analyses attest to the independence of factor scores on the WIHIC and TOSRA.

Further validation data for the QTI were obtained by conducting interscale correlation analysis. According to the Leary model, correlations between adjacent scales are expected to be highest and positive, and also this correlation should gradually decrease as scales move further apart from each other until opposite scales have the highest negative correlation. Table 4.4 generally supports the circumplex model of the QTI. For example, the Helping/Friendly scale was correlated closely and positively with Leadership (0.80) and Understanding (0.81), but this correlation decreased with the other scales until it reached the highest negative values of -0.49 with Dissatisfied, which is directly opposite. Figure 4.1 shows the assumptions of the circumplex model of the QTI using the Helping/Friendly scale's correlations with its adjacent and opposite scales.

The ability of each scale of the WIHIC (Table 4.2) and the QTI (Table 4.3) to differentiate between the perceptions of students in different classrooms was explored using ANOVA with class membership as the main effect. Statistically significant differences ($p<0.01$) between student perceptions in different classes were found for all the scales of the WIHIC and the QTI. The eta² statistic, which represents the proportion of variance in scale scores accounted for by class membership, ranged

from 0.10 (Task Orientation) to 0.19 (Teacher Support) for the WIHIC and from 0.13 (Uncertain) to 0.29 (Understanding) for QTI.

Thus this study provides further evidence for the validity and reliability of the WIHIC and the QTI for use in assessing the learning environment and teacher-student interactions with New York Regents biology students. My results for the validity of the WIHIC and QTI replicate numerous past studies in other countries. For example, Aldridge, Fraser and Huang (1999) cross-validated the WIHIC as part of a cross-national study of science classroom environments with a sample of 1,081 Grade 8 and 9 general science students from 50 classes in 25 schools in Western Australia and 1,879 Grade 7–9 students from 50 classes in 25 schools in Taiwan. In Singapore, Chionh and Fraser (2009) cross-validated a version of the WIHIC with a sample of 2,310 Secondary Four (Grade 10) geography and mathematics students. Kim, Fisher and Fraser (2000) cross-validated both the WIHIC and QTI questionnaires in their investigation of classroom environment and teacher interpersonal behavior in secondary science classes in Korea with a sample of 543 students. In a cross-national validation of the WIHIC, Dorman (2003) used a sample of 3,980 Grade 8, 10, and 12 students from Australia, the UK, and Canada. In Netherlands, the QTI was cross-validated and used to investigate relationships between interpersonal teacher behavior and student achievement and attitudes to science (Wubbels & Levy, 1993) with a sample of 1,105 students and 66 teachers. In all these studies, data analyses confirmed the validity and reliability of the WIHIC and QTI scales.

A total of 40 students were interviewed by asking them questions pertaining to each scale of the QTI, WIHIC and TOSRA. The main purpose of the interviews was to reinforce the construct validity of these questionnaires when used with the sample of high school biology students in New York by checking whether interview comments were mostly consistent with the means obtained for each scale. For example, for the WIHIC scales, the highest mean score was for Task Orientation (4.08) and all the students interviewed stressed the importance of finishing their assigned work because this was an important part of their grade. For the WIHIC scale of Investigation, which had the lowest scale mean (2.90), students reported that their teacher chose almost all of the investigations that they carried out. For the QTI scales, Uncertain had the lowest mean score of 2.02, corresponding to the Seldom response. Most of the

students said that their teacher was seldom uncertain. Also, for the QTI, students who reported that they perceived their teacher as strict were the same students who scored those teachers high on the Strict scale. This suggests that these instruments generally are capable of measuring what they are intended to measure. Most students reported a neutral opinion about their attitudes relevant to the Adoption of Scientific Attitudes and Enjoyment of Science Lessons scales, which corresponds to the Sometimes response and the scale mean of 3 reported for each attitude scale, thereby supporting the construct validity of these attitudes scales.

Hence both quantitative and qualitative results confirmed that the WIHIC, QTI and TOSRA are suitable for use in Living Environment (biology) classrooms in New York.

Research objective 2

To investigate associations between the classroom learning environment and students':

a. Science achievement

b. Attitudes to science.

Simple correlations and multiple regression analyses were carried out to investigate associations between the classroom learning environment (WIHIC scales) and student outcomes of attitude and achievement (Table 5.1). Analyses were conducted separately with the student and the class as the units of analysis.

The simple correlation between both Enjoyment of Science Lessons and Adoption of Scientific Attitudes and every WIHIC scale was statistically significant and were positive for both units of analysis.

The multiple correlations for the set of WIHIC scales was 0.54 for Enjoyment and 0.63 for Adoption with the individual student as unit of analysis and was 0.80 for Enjoyment of Science Lessons and 0.90 for Adoption of Science Attitudes with the class as the unit of analysis. These multiple correlations were statistically significant for each level of analysis, indicating an overall multivariate relationship between classroom environment and student attitudes.

Inspection of beta weights revealed that all the WIHIC scales except Cooperation were significantly and independently associated with student Enjoyment with the individual student as the unit of analysis. But, Student Cohesiveness was negatively associated with the Enjoyment scale with the student as unit of analysis. With class as the unit of analysis, only Student Cohesiveness (negatively) and Teacher Support (positively) were significantly and independently associated with Enjoyment.

Involvement, Investigation, Task Orientation, Cooperation and Equity were significantly and independently related to Adoption of Scientific Attitudes with the student as the unit of analysis. With the class as unit of analysis, Teacher Support, Investigation and Cooperation were significantly and independently associated with Adoption. All of these significant associations were positive, suggesting that students adopt a positive attitude to science in classrooms where they perceive that students are involved, carry out investigations, are on task, cooperate and work with each other, and where their teachers treat every student equitably. With the class as the unit of analysis, the findings suggest that a learning environment where teachers are perceived as being supportive and where students are involved in investigations and cooperate with each other promotes more positive attitudes to science among students.

Overall, positive relationships existed between student attitudes and the learning environment aspects assessed by the WIHIC. For student achievement, simple correlation analysis (Table 5.1) revealed that there was a significant correlation between achievement and four of the WIHIC scales (Student Cohesiveness, Involvement, Task Orientation and Equity) with the student as the unit of analysis. With the class as unit of analysis, only Student Cohesiveness was significantly correlated with achievement. Also significant correlations were positive.

The multiple correlation for the set of WIHIC scales was 0.17 for achievement with the student as the unit of analysis and was statistically significant ($p<0.05$) and was 0.48 with class as the unit of analysis but was not statistically significant (Table 5.1).

Beta weights revealed that two WIHIC scales (Teacher Support and Equity) were significantly and independently associated with achievement with the student as the

unit of analysis. With the class as the unit of analysis, none of the WIHIC scales was significantly and independently associated with achievement.

Teacher Support was negatively, significantly and independently associated with achievement, while Equity was positively, significantly and independently associated with achievement, with the student as the unit of analysis. Consequently, where students perceived that the class operated equitably, students achieved better in their Regents science examination. Teacher Support being negatively, significantly and independently associated with achievement could possibly be because academically weaker students were given more attention and support by the teacher than were the other students. This suggests that the quality of the classroom environment is important for students' achievement.

Research objective 3

To investigate associations between teacher interpersonal behavior and students':

a. **Science achievement**
b. **Attitudes to science.**

Simple correlation and multiple regression analyses were carried out to determine associations between teacher interpersonal behavior (QTI scales) and the student outcomes of attitudes and achievement (Table 5.2) with both the student and the class as the units of analysis.

With the student as the unit of analysis, the four QTI scales of Leadership, Understanding, Helping/Friendly and Student Responsibility/Freedom were positively and significantly correlated with Enjoyment, which is expected because these scales have positive connotations. As expected, two QTI scales with a negative connotation (Admonishing and Dissatisfied) were negatively and significantly correlated with Enjoyment. But the results of this study differ markedly from those of many previous studies in that, with the class as the unit of analysis, positive and significant correlations were found between Enjoyment and two of the four QTI scales with a positive connotation (Leadership and Understanding) and also with two of the four QTI scales with a negative connotation (Uncertain and Admonishing). Also, with the

class as the unit of analysis, negative and significant correlations were found between Enjoyment and Student Responsibility/Freedom (which has a positive connotation and was not anticipated) and two QTI scales with a negative connotation (Dissatisfied and Strict) which was anticipated.

There were some anomalies with the findings for these associations. Student Responsibility/Freedom, which has positive connotation, was negatively correlated with Enjoyment with the class as the unit of analysis. As suggested during interviews, this could be because most of the students expressed that they were given more responsibilities than freedom. Also some students felt that some of their classmates could not handle whatever freedom was given to them because they usually could neither behave themselves nor stay focused and on task. The Uncertain scale was also positively correlated with Enjoyment with the class as the unit of analysis, but findings from interviews suggested that the students did not perceive their science teachers as uncertain. Also Admonishing was found to be positively correlated with Enjoyment with the class as the unit of analysis, perhaps because most of the students in this study viewed Admonishing teacher behavior as necessary for managing badly-behaved students so that the rest of the class could concentrate on their science lessons. Students tended to associate Admonishing behavior with maintaining an orderly and structured environment that is conducive to learning**.**

Table 5.2 shows that, with the student as the unit of analysis, the Adoption scale was positively and statistically significantly correlated with the four QTI scales with a positive connotation (Leadership, Understanding, Helping/Friendly and Student Responsibility/Freedom) and negatively and significantly correlated with three of the four QTI scales with a negative connotation (Uncertain, Admonishing and Dissatisfied) as expected. With class as the unit of analysis, correlations were mostly in the expected direction with a few exceptions. Anomalies were found with the two QTI scales of Dissatisfied and Strict, which were positively associated with Adoption of Scientific Attitudes with the class as the unit of analysis. Interview findings gave important insights into why this happened. Students reported that they adopt better attitudes when they perceive that their teachers are dissatisfied with their behaviors, mainly because their classroom participation and behavior influence their grades. Also Strict teacher behavior was accepted by the majority of the students interviewed

as being an important method for controlling the class and providing a structured learning environment.

A statistically significant multiple correlation was found between each attitude scale (Enjoyment or Adoption) and the set of all QTI scales for both the student and the class as the units of analysis. This suggests that students' attitudes to science are associated with their perceptions of their teachers' interpersonal behavior.

An examination of beta weights revealed that the Leadership, Understanding, Helping/Friendly, Uncertain, and Dissatisfied scales were positively and independently associated with Enjoyment of Science Lessons with the student as the unit of analysis whereas, with the class as the unit of analysis, only the QTI scale of Uncertain was positively and independently associated with Enjoyment.

The Adoption of Scientific Attitudes scale was positively and independently associated with the QTI scales of Leadership and Understanding with the student as the unit of analysis. This suggests that students display a more favorable attitude when they perceive their teachers to display Leadership and Understanding behaviors.

Result for the analyses of associations between QTI scales and students' achievement for two units of analysis are summarized in Table 5.2. Simple correlations analysis revealed that six out of eight scales of the QTI were significantly associated with student achievement with the student as unit of analysis. Three of the QTI scales with a positive connotation, namely, Leadership, Understanding, Helping/Friendly, and one of the QTI scales with a negative connotation (Uncertain) were positively correlated with achievement. As expected, the two scales of Dissatisfied and Strict were negatively correlated with student achievement with the student as the unit of analysis.

With the class as the unit of analysis, the six QTI scales of Leadership, Understanding, Helping/Friendly, Uncertain, Admonishing and Dissatisfied showed significant associations with student achievement. As expected, positive associations existed between QTI scales with a positive connotation (Leadership, Understanding and Helping/Friendly) and achievement, whereas a negative association existed

between QTI scales with a negative connotation (Uncertain, Admonishing and Dissatisfied) and achievement.

With the student as the unit of analysis, a statistically significant multiple correlation was found between achievement and the set of all QTI scales. The beta weights revealed that Uncertain behavior was the only QTI scale that was negatively, independently and significantly associated with achievement with the student as the unit of analysis.

This suggests that students' achievement, as measured by the standardized state test, is higher in classes where students perceive their teacher as being helping/friendly, a good leader and understanding. Also, better student achievement was found in the classes of teachers who are more cooperative and less uncertain.

Research objective 4

To investigate the magnitude of the unique and common contributions of the WIHIC and QTI in explaining variance in students':

a. **Science achievement**
b. **Attitudes to science**.

A commonality analysis was undertaken in order to ascertain the unique and common contributions of classroom learning environment (assessed by WIHIC) and interpersonal teacher behavior (assessed by QTI) in explaining variance in the three student outcomes of Enjoyment, Adoption, and achievement. Table 5.3 reports the results of commonality analyses that were conducted using the square of multiple correlation (R^2) to examine the unique and joint contributions of WIHIC and QTI in explaining variance in student outcomes.

For Enjoyment of Science Lessons, the WIHIC made a unique contribution to variance of 0.07 beyond that contributed by the QTI (Table 5.3). The QTI made a unique contribution to variance in Enjoyment scores of 0.18 beyond that attributable to the WIHIC. The common contribution of the WIHIC and QTI to variance in Enjoyment scores was 0.12 and relatively large. This finding suggests that, whilst each instrument made somewhat overlapping contributions to the variance in student

Enjoyment of Science Lessons, each instrument also made a unique contribution. The benefit of using both instruments together to predict Enjoyment is supported by this finding. Therefore, it is worthwhile to include both the WIHIC and QTI in the same study of students' enjoyment of science.

For Adoption of Scientific Attitudes, the WIHIC made a unique contribution to variance of 0.08 beyond that contributed by the QTI (Table 5.3). The QTI's contribution to variance in Adoption scores was only 0.03 beyond that attributable to the WIHIC. The common contribution of the WIHIC and QTI to variance in Adoption scores was 0.21 and quite high. Overall, the results in Table 5.3 suggest that it is not useful to include both the WIHIC and QTI within the same study of students' adoption of scientific attitudes.

For achievement, the WIHIC made a unique contribution to variance of only 0.02 beyond that contributed by the QTI. The QTI made a unique contribution to variance in achievement score of only 0.04 beyond that attributable to the WIHIC. The common contribution of the WIHIC and QTI to variance in achievement score was 0.01 and low. In terms of achievement, neither the WIHIC nor QTI accounted for much unique or common variance.

6.4 IMPLICATIONS OF FINDINGS FROM THE STUDY

When the QTI, the WIHIC and the TOSRA were used together for the first time with a New York sample, validation data were provided for these instruments. Other researchers therefore can now use these instruments with confidence with this population. Also teachers can use the WIHIC and QTI to guide improvements in their classroom environments and teacher-student interactions. For example, teachers could administer the questionnaires early in the school year and then adjust their classroom practices according to students' needs. Then, in the middle of the school year, teachers could administer the questionnaires again to identify differences and similarities in the students' responses and then use the results as a focus for discussion and reflection. This study, therefore, provides New York teachers with instruments that can be easily administered in classrooms to assess students' perceptions of classroom learning environment and teachers' interpersonal behavior. These

questionnaires are economical and parsimonious and can be easily administered in as little as 20 minutes.

Findings from this investigation of associations between teachers' interpersonal behavior, classroom learning environment and students' attitudinal and achievement outcomes can help teachers to understand how the classroom environment and teacher interpersonal behavior are linked to student outcomes. Therefore, if teachers wish to improve the achievement and attitudes of their students, they could emphasize those behaviors that are positively linked to these outcomes.

Finally this study's use of qualitative student interviews supported the construct validity of the questionnaires and provided information that was mostly consistent with findings from the quantitative data (questionnaire scale means). In the light of this integration of quantitative and qualitative methods, teachers might choose to use discussions (informal interviews) with students as a tool of reflection on their teaching.

6.5 CONSTRAINTS AND LIMITATIONS

The findings from this research can be generalized to similar situations in the USA, but this has to be done with caution because of the limitations of the study. The limitations of this study relate mainly to the limited time frame and sample size, the instruments used and how the data were collected.

Because there were many items in the questionnaires (the WIHIC, the QTI and the TOSRA were combined and administered as one questionnaire), some students might have become fatigued and therefore did not concentrate on reading and completing all of the items. Some students might have had trouble reading the questionnaire but did not ask for help. Probably, because of these and other reasons, some students left some questions blank, thus rendering those questionnaires unusable. Many questionnaires were discarded because of incompleteness.

The help of other teachers was solicited in collecting some of the data. Some of these teachers did not implement all of my recommended procedures for the data collection,

which rendered some of the data initially collected useless for the study. A lot of time was wasted in going back and repeating the process and, in some cases, repeating data collection was not possible. Thus, time was another major constraint that had an effect on reducing the possible sample size.

Some of the teachers were not completely willing to help with the data collection but they did not say so. These teachers did not stress to students the importance of completing all items on the questionnaires and did not provide the necessary guidance to the small number of students who might have needed it. Because of this, some questionnaires were not properly completed and therefore were discarded.

Some school district administrators refused access to their schools for conducting the research. This limited the number of schools used to only five. Although these five schools were reasonably representative of the high school biology students, some of the schools have a very large number of biology classes.

For the achievement data, the limitation of time and nature of the thesis, as well as school district policy, also restricted the scope and sample size. One of the aims of this study was to investigate associations between students' achievement and classroom learning environment and teachers' interpersonal behavior. The results of the Regents examination taken just before the end of the school year were used as a measure of students' achievement. For the achievement scores to be reliable, and matched with the questionnaire data collected in my study, they needed to be collected within the same school year. A larger sample would have been easily possible if the Regents examination were taken after two years of studying Living Environment (Biology). It would have been preferable for more time to be spent in collecting more data. Also the school district policy of requiring parental approval before releasing students' records constrained the sample size for student achievement. Some schools did not release the Regents examination results of their students who provided the survey data, claiming at the last minute that they did not realize that they were needed even though this was covered in the information sheet given out to them before the research survey was initiated. Because this information was given to the researcher at the end of the school year, there was no time left to include more students who were out of school already.

Finally, the interview data should be interpreted with caution as all the students interviewed came from the researcher's school. It would have been preferable also to interview students from some of the other schools used in the study.

6.6 RECOMMENDATIONS FOR FURTHER RESEARCH

Although this study had some limitations, it has opened a new door towards investigating associations between students' perceptions of their learning environment and teacher interpersonal behaviors and students' outcomes of attitudes and achievement. But additional research is needed to investigate whether the magnitudes of associations between learning environment, teacher interpersonal behaviors and student outcomes are different for male and female students and for different ethnic and cultural groups.

This study could be replicated to include preferred forms and teachers' version of the QTI and the WIHIC. Validating these other versions of the questionnaires probably would enhance the potential usefulness of the instruments and also provide insight into teachers' perception of the learning environment, which could be compared with the perceptions of the students.

A further study could include larger and more diverse samples by using more schools. Also, different science subjects (such as chemistry, earth science, environmental science) other than biology could be used in conducting similar research so that a comparison could be made between the findings for the different subject areas.

More extensive use of qualitative methods of data collection (e.g. classroom observations) in future research is likely to enhance insights.

6.7 SUMMARY AND CONCLUDING REMARKS

This chapter brings the thesis to an end. Associations between teachers' interpersonal behavior, classroom learning environment and students' outcomes have been identified by using the WIHIC and the QTI questionnaires, two scales of the TOSRA (Adoption of Scientific Attitudes and Enjoyment of Science Lessons) and interviews.

Validation data for the WIHIC, the QTI and the TOSRA were provided for a sample of 785 Living Environment (biology) students from five New York schools in 75 classrooms.

Multiple regression analyses revealed that: all the WIHIC scales except Cooperation were significantly and independently associated with student Enjoyment; all WIHIC scales except Student Cohesiveness were significantly and independently related to Adoption of Scientific Attitudes; and two of the seven WIHIC scales (Teacher Support and Equity) were significantly and independently associated with achievement. Thus students' perceptions of their classroom environment were important for both students' attitudes and achievement.

Multiple regression analyses also revealed that the QTI scales of Leadership and Understanding scales were positively and independently associated with both attitude scales (Enjoyment of Science Lessons and Adoption of Scientific Attitudes), and that the Uncertain scale was negatively and independently associated with achievement. This suggests that students had more favorable attitudes towards science where they perceived their teacher as showing leadership, being understanding and helping/ friendly.

This study's use of qualitative student interviews supported the construct validity of the questionnaires because students' comments were mostly consistent with the findings of the quantitative data (questionnaire scale means). In the light of this integration of quantitative and qualitative methods, teachers might choose to use discussions (informal interviews) with students as a tool for reflection on their teaching.

It is hoped that the present study makes a worthwhile contribution to the field of learning environment research. Also the researcher hopes that the findings of the present study could be used by science teachers to guide the development of more positive classroom learning environments and student-teacher interactions that are productive in terms of students' attitudes and achievement.

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Appendix A

INFORMATION/CONSENT SHEET

This is to inform you about a doctorate research project in which your child might be participating. The title of the proposed research is **Associations Between Teachers' Interpersonal Behavior, Classroom Learning Environment and Students' Outcomes.**

I am doing my doctorate degree with Curtin University situated at Australia under the supervision of Dr. Barry Fraser. Currently I am a high school biology teacher at Bellport High school of SOUTH COUNTRY CENTRAL SCHOOL DISTRICT.

The aims of the proposed study are to:

1. Cross-validate the QTI, WIHIC, and TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with a New York sample.
2. Investigate associations between teacher interpersonal behavior and students':
    a. Science achievement
    b. Attitudes to science
3. Investigate associations between the classroom learning environment and students':
    a. Science achievement
    b. Attitudes to science
4. Investigate the magnitude of the unique and common contributions of the WIHIC and QTI in explaining variance in students':
    a. Science achievement
    b. Attitudes to science.

The students will complete the questionnaire from which the quantitative data will be generated. Interviews will also be conducted on a few students after the completion of the questionnaires to gather qualitative data. At the end of the school year, students' grades on Living Environment (Biology) Regents examination will be collected for the students who provided the survey data. This will be used as a measure of achievement.

Teachers, students and school will be coded as numeric values or letters to guarantee anonymity and remove identifying features from the data during data preparation and entry. No student or school will be identified in the study. Data gathered will be treated very confidentially and will be available to the researcher and supervisor only. Participants will remain anonymous to maintain privacy and confidentiality. However, the kind of population from which the data will be collected will be described so that someone else can repeat the procedure.

The student decides whether he/she wants to participate in this study and is free to drop at any time they feel they no longer wish to continue without prejudice or negative consequences.

There is no risk to participants.

Consideration

The QTI and the WIHIC questionnaires as well as items from the TOSRA will be merged into one questionnaire to minimize the amount of instruction time used to complete the survey. The questionnaire can be completed in less than 25 minutes.

Feedback information will be given to the participants after the collection of data. A summary of the result will be offered to the participants when possible. A certificate of participation will also be given to the participants to acknowledge their effort and time spent on the study.

You can contact me at nmadu@southcountry.org should you require any further information.

Should you wish to make a complaint on ethical grounds, you can contact hrec@curtin.edu.au or in writing C/- office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth WA 68453.

The project has been approved by the Curtin University Human Research Ethics Committee.

CONSENT FORM

Please read and sign the consent form for the doctorate research project:

Associations between teachers' interpersonal behavior, classroom learning environment and students' outcomes.

I have been informed of and understand the purposes of the study.

I have been given an opportunity to ask questions.

I understand I can withdraw at any time without prejudice.

Any information which might potentially identify me will not be used in published material.

I agree to participate in the study as outlined to me.

Name of participant_____

Signature_____

Date._____

Appendix B

PROPOSAL TO CONDUCT DOCTORAL RESEARCH SURVEY IN YOUR HIGH SCHOOL BIOLOGY CLASSROOMS

This is to seek your permission to use some of the biology classrooms in your high school to conduct a doctorate research survey. I am doing my doctorate degree with Curtin University situated at Australia under the supervision of Dr. Barry Fraser. Currently I am a high school biology teacher at Bellport High school of SOUTH COUNTRY CENTRAL SCHOOL DISTRICT. Below is the aim of the study as contained in the information sheet that will be sent home to parents. The parents' consents are needed for all minors to be able to participate in the study.

INFORMATION SHEET

This is to inform you about a doctorate research project in which your child might be participating. The title of the proposed research is **Associations Between Teachers' Interpersonal Behavior, Classroom Learning Environment and Students' Outcomes.**

The aims of the proposed study are to:

1. Cross-validate the QTI, WIHIC, and TOSRA in terms of reliability, factor structure, discriminant validity and ability to differentiate between classrooms when used with a New York sample.
2. Investigate associations between teacher interpersonal behavior and students':
    a. Science achievement
    b. Attitudes to science
3. Investigate associations between the classroom learning environment and students':
    a. Science achievement

   b. Attitudes to science
4. Investigate the magnitude of the unique and common contributions of the WIHIC and QTI in explaining variance in students':
   a. Science achievement
   b. Attitudes to science.

.

The students will complete the questionnaire from which the quantitative data will be generated. Interviews will also be conducted on a few students after the completion of the questionnaires to gather qualitative data. At the end of the school year, students' grades on Living Environment (Biology) Regents examination will be collected for the students who provided the survey data. This will be used as a measure of achievement.

Teachers, students and school will be coded as numeric values or letters to guarantee anonymity and remove identifying features from the data during data preparation and entry. No student or school will be identified in the study. Data gathered will be treated very confidentially and will be available to the researcher and supervisor only. Participants will remain anonymous to maintain privacy and confidentiality. However, the kind of population from which the data will be collected will be described so that someone else can repeat the procedure.

The student decides whether he/she wants to participate in this study and is free to drop at any time they feel they no longer wish to continue without prejudice or negative consequences. There is no risk to participants.

Consideration:

The QTI and the WIHIC questionnaires as well as items from the TOSRA will be merged into one questionnaire to minimize the amount of instruction time used to complete the survey. The questionnaire can be completed in less than 25 minutes.

Feedback information will be given to the participants after the collection of data. A summary of the result will be offered to the participants when possible. A certificate

of participation will also be given to the participants to acknowledge their effort and time spent on the study. You can contact me at nmadu@southcountry.org should you require any further information. Should you wish to make a complaint on ethical grounds, you can contact hrec@curtin.edu.au or in writing C/- office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth WA 68453.
The project has been approved by the Curtin University Human Research Ethics Committee.

CONSENT FORM

Please read and sign the consent form for the doctorate research project:

Associations between teachers' interpersonal behavior, classroom learning environment and students' outcomes.
I have been informed of and understand the purposes of the study.
I have been given an opportunity to ask questions.
I understand I can withdraw at any time without prejudice.
Any information which might potentially identify me will not be used in published material.

I agree to participate in the study as outlined to me.

Name of participant_____

Signature_____

Date._____

I will highly appreciate it if given the opportunity to use your school.
Thank you,

Nneka Madu.

Appendix c

certificate of participation

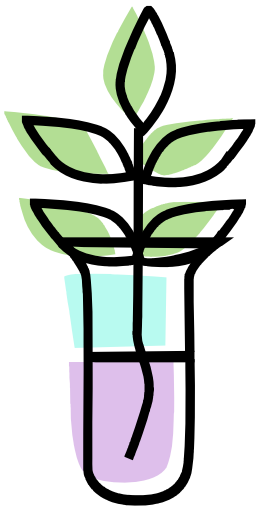
This certificate of participation is thankfully presented to

For your kind co-operation in this study on

Associations Between Teachers' Interpersonal

Behavior, Learning Environment and Students'

outcomes



Date **Nneka Madu**

Appendix D

QUESTIONNAIRES USED FOR THE STUDY (WIHIC, QTI AND TOSRA COMBINED)

STUDENTS' OPINIONS ABOUT THIS SCIENCE CLASS

Directions for Students

This questionnaire contains statements about this science class. You will be asked how often each statement is true for this class.

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 statement is true	**Almost Never**
2 if the statement is true	**Seldom**
3 if the statement is true	**Sometimes**
4 if the statement is true	**Often**
5 if the statement is true	**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 that you were given the statement: "I choose my partners for group discussion." You would need to decide whether you think you choose your partners 'Almost Never', 'Seldom', 'Sometimes', 'Often,' or 'Almost Always'. For example, if you selected 'Often', you would circle the number 4 on your questionnaire.

All items and scales in this questionnaire were used with their authors' permission. Items 1-56 are from the What Is Happening In this class? (WIHIC) questionnaire (Aldridge, Fraser & Huang, 1999). Items 57-70 are based on the Test of Science-Related Attitudes (TOSRA, Fraser, 1981). Items 71-118 are from the Questionnaire on Teacher Interaction (QTI, Wubbels, 1993).

Your Name:_____

Male _____Female _____

Teacher's Name:_____

School: _____

Grade: _____

	SC	Almost Never	Seldom	Sometime	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 am friendly to members of this class.	1	2	3	4	5
4	Members of the class are my friends.	1	2	3	4	5
5	I work well with other class members.	1	2	3	4	5
6	I help other class members who are having trouble with their work.	1	2	3	4	5
7	Students in this class like me.	1	2	3	4	5
8	In this class, I get help from other students.	1	2	3	4	5
	TS					
9	The teacher takes personal interest in me	1	2	3	4	5
10	The teacher goes out his/her way to help me	1	2	3	4	5
11	The teacher considers my feelings.	1	2	3	4	5
12	The teacher helps me when I have trouble with the work.	1	2	3	4	5
13	The teacher talks with me.	1	2	3	4	5
14	The teacher is interested in my problems.	1	2	3	4	5
15	The teacher moves about the class to talk with me.	1	2	3	4	5
16	The teacher's questions help me to understand.	1	2	3	4	5
	INVOLV					
17	I discuss ideas in class.	1	2	3	4	5
18	I give my opinions during class discussions.	1	2	3	4	5
19	The teacher asks me questions.	1	2	3	4	5
20	My ideas and suggestions are used during classroom discussions.	1	2	3	4	5
21	I ask the teacher questions	1	2	3	4	5
22	I explain my ideas to other students.	1	2	3	4	5
23	Students discuss with me how to go about solving problems.	1	2	3	4	5

24	I am asked to explain how I solve problems.	1	2	3	4	5
	INV					
25	I carry out investigations to test my ideas.	1	2	3	4	5
26	I am asked to think about the evidence for statements.	1	2	3	4	5
27	I carry out investigations to answer questions coming from discussions.	1	2	3	4	5
28	I explain the meaning of statements diagrams and graphs.	1	2	3	4	5
29	I carry out investigations to answer questions which puzzle me.	1	2	3	4	5
30	I carry out investigations to answer the teacher's questions.	1	2	3	4	5
31	I find out answers to questions by doing investigations.	1	2	3	4	5
32	I solve problems by using information obtained from my own investigation.	1	2	3	4	5
	TO	**Almost Never**	**Seldom**	**Sometime**	**Often**	**Almost Always**
33	Getting a certain amount of work done is important to me.	1	2	3	4	5
34	I do as much as I set out to do.	1	2	3	4	5
35	I know the goals for this class.	1	2	3	4	5
36	I am ready to start this class on time.	1	2	3	4	5
37	I know what I am trying to accomplish in this class.	1	2	3	4	5
38	I pay attention during this class.	1	2	3	4	5
39	I try to understand the work in this class.	1	2	3	4	5
40	I know how much work I have to do.	1	2	3	4	5
	COOP					
41	I cooperate with other students when doing assignment work.	1	2	3	4	5
42	I share my books and resources with other students when doing assignments	1	2	3	4	5
43	When I work in groups in this class there is teamwork.	1	2	3	4	5
44	I work with other students on projects in this class.	1	2	3	4	5
45	I learn from other students in this class.	1	2	3	4	5
46	I work with other students in this class.	1	2	3	4	5
47	I cooperate with other students on class activities.	1	2	3	4	5
48	Students work with me to achieve class goals.	1	2	3	4	5
	EQU					
49	The teacher gives as much attention my questions as to other student’s questions.	1	2	3	4	5
50	I get the same amount of help from the teacher as do other students.	1	2	3	4	5
51	I have the same amount of say in this class as other students.	1	2	3	4	5
52	I am treated the same as other students in this class.	1	2	3	4	5
53	I receive the same encouragement from the teacher as other students do.	1	2	3	4	5

54	I get the same opportunity to contribute to class discussions as other students.	1	2	3	4	5
55	My works receive as much praise as other students.	1	2	3	4	5
56	I get the same opportunity to answer questions as other students.	1	2	3	4	5
	ASA					
57	I enjoy reading about things which disagree with my previous ideas.	1	2	3	4	5
58	I dislike repeating experiments to check that I get the same result.	1	2	3	4	5
59	I am curious about the world in which we live.	1	2	3	4	5
60	Finding about new things is unimportant.	1	2	3	4	5
61	I like to listen to people whose opinion is different from mine.	1	2	3	4	5
62	In science experiments, I like to use new methods which I have not used before.	1	2	3	4	5
63	In science experiments, I report unexpected results as well as expected ones.	1	2	3	4	5
	ENJ					
64	Science lessons are fun.	1	2	3	4	5
65	I dislike science lessons	1	2	3	4	5
66	Schools should have more science lessons each week.	1	2	3	4	5
67	Science lessons bore me.					
68	Science is one of the most interesting school subjects.	1	2	3	4	5
69	I really enjoy going to science lessons.	1	2	3	4	5
70	I look forward to science lessons.	1	2	3	4	5
	QTI	**Almost Never**	**Seldom**	**Sometime**	**Often**	**Almost Always**
71	This teacher talks enthusiastically about her/his subject.	1	2	3	4	5
72	This teacher trusts us.	1	2	3	4	5
73	This teacher seems uncertain.	1	2	3	4	5
74	This teacher gets angry unexpectedly.	1	2	3	4	5
75	This teacher explains things clearly.	1	2	3	4	5
76	If we don't agree with this teacher, we can talk about it.	1	2	3	4	5
77	This teacher is hesitant.	1	2	3	4	5
78	This teacher gets angry quickly.	1	2	3	4	5
79	This teacher holds our attention	1	2	3	4	5
80	This teacher is willing to explain things again.	1	2	3	4	5
81	This teacher acts as if he/she does not know what to do.	1	2	3	4	5
82	This teacher is too quick to correct us when we break a rule.	1	2	3	4	5

83	This teacher knows everything that goes on in this classroom.	1	2	3	4	5
84	If we have something to say, this teacher will listen.	1	2	3	4	5
85	This teacher lets us boss her/him around.	1	2	3	4	5
86	This teacher is impatient.	1	2	3	4	5

87	This teacher is a good teacher.	1	2	3	4	5
88	This teacher realizes when we don't understand.	1	2	3	4	5
89	This teacher is not sure what to do when we fool around.	1	2	3	4	5
90	It is easy to pick a fight with this teacher.	1	2	3	4	5

91	This teacher acts confidently.	1	2	3	4	5
92	This teacher is patient.	1	2	3	4	5
93	It's easy to make a fool out of this teacher.	1	2	3	4	5
94	This teacher is sarcastic.	1	2	3	4	5

95	This teacher helps us with our work.	1	2	3	4	5
96	We can decide some things in this teacher's class.	1	2	3	4	5
97	This teacher thinks that we cheat.	1	2	3	4	5
98	This teacher is strict.	1	2	3	4	5

99	This teacher is friendly.	1	2	3	4	5
100	We can influence this teacher.	1	2	3	4	5
101	This teacher thinks that we don't know anything.	1	2	3	4	5
102	We have to be silent in this teacher's class.	1	2	3	4	5
	QTI	**Almost Never**	**Seldom**	**Sometime**	**Often**	**Almost Always**
103	This teacher is someone we can depend on.	1	2	3	4	5
104	This teacher lets us fool around in class.	1	2	3	4	5
105	This teacher puts us down.	1	2	3	4	5
106	This teacher's tests are hard.	1	2	3	4	5

107	This teacher has a sense of humor.	1	2	3	4	5
108	This teacher lets us get away with a lot in class.	1	2	3	4	5
109	This teacher thinks that we can't do things well.	1	2	3	4	5
110	This teacher's standards are very high.	1	2	3	4	5

111	This teacher can take a joke.	1	2	3	4	5
112	This teacher gives us a lot of free time in class.	1	2	3	4	5
113	This teacher seems dissatisfied.	1	2	3	4	5
114	This teacher is severe when marking papers.	1	2	3	4	5

115	This teacher's class is pleasant.	1 2 3 4 5
116	This teacher is lenient.	1 2 3 4 5
117	This teacher is suspicious.	1 2 3 4 5
118	We are afraid of this teacher	1 2 3 4 5

Appendix E

WRITTEN INTERVIEW QUESTIONS

Name_____

Teacher _____

1. What can you say about your science teachers' leadership skills?

   _____

   _____

   _____

   _____

   _____

2. Do you perceive your science teacher to be kind and caring? Explain

   _____

   _____

   _____

   _____

   _____

3. Does your science teacher leave you without directions to figure out how to complete a task? Explain

   _____

   _____

   _____

   _____

   _____

4. Is your science teacher:

   a) Helping/Friendly? Explain.

   _____

   _____

   _____

   _____

   _____

b) A good leader? Explain.

c) Understanding? Explain

d) Strict? Explain

e) Admonishing? Explain

f) Dissatisfied? Explain

g) Uncertain? Explain

h) Gives students responsibility/freedom? Explain

5. Are students in this class helpful and supportive of each other? Explain

6. Does your teacher give you enough support in your science learning? Explain

7. Are you attentive and participating in this class (involve)? Explain

8. Are you allowed to choose what investigation to do in this class or does your teacher choose all the investigations? Explain

9. Do you often complete planned activities and stay on subject matter in this class (task orientated)? Explain

10. Is there anything in this class that hinders your cooperation with other students in your science learning?

11. Does your teacher treat everybody equally in this class?

12. What do you like most about your Science teacher? Science class?

13. What do you dislike most about your Science teacher? Science class?

14. Would you like to read things which disagree with your ideas, and do you dislike many trials in an experiment? Explain

_____

_____

_____

_____

_____

15. Are you curious about the world, view finding new things as important, listen to people with different scientific opinion, like to apply new methods in investigations, and report unexpected findings that might prove your hypothesis wrong?

_____

_____

_____

_____

_____

_____

Appendix F

ORAL INTERVIEW QUESTIONS

WIHIC QUESTIONS:

1. Did your classmates know, help or support you during science activities in this classroom?
2. Does your teacher help, support, trust and show interest in you as far as your learning activities in this classroom are concerned?
3. Are you always attentive and participate well in this class?
4. How often do you get to choose the investigation you do in your science class? Do you apply scientific skills and processes of inquiry in problem solving and investigations?
5. Do you often complete planned activities and stay on the subject matter in this class?
6. Are students in this class cooperative and share their books and resources with each other when doing assignment work, team work or projects?
7. Does your science teacher treat everybody equally in this class?

QTI QUESTIONS:

8. What can you say about your science teacher's leadership skill in terms of leading, organizing, giving orders, determining procedures and structuring the classroom situation?
9. Does your science teacher listen with interest and empathy and generally show understanding and would you say that your teacher is open to you?
10. Would you say that your teacher shows interest, behaves in a friendly or considerate manner and inspires confidence and trust in you?
11. What can you say about your level of responsibility and freedom in this class?
12. Does your science teacher seem uncertain or keep a low profile with you?
13. Does your teacher unexpectedly get angry or punish students?

14. Does your teacher express dissatisfaction or look unhappy with her teaching?
15. Is your science teacher strict?

TOSRA QUESTIONS

16. Would you like to read things which disagree with your ideas, do you dislike many trials in an experiment, are you curious about the world, and do you view finding new things as important, listen to people with different scientific opinion, like to apply new methods in investigations, and report unexpected findings that might prove your hypothesis wrong?
17. Do you like and enjoy your science lessons?