Science and Mathematics Education Centre

The use of Classroom Environment Improvement Plans in an attempt to change aspects of teacher interpersonal behaviour and the science laboratory learning environment in order to improve student 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 contains no material previously published by any other person except where due acknowledgement has been made.

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ABSTRACT

The learning environment has been the focus of considerable educational research over a long period of time. The study reported in this thesis utilises the perceptions of 208 junior science students from a North Queensland state secondary school to inform classroom environment improvement plans developed and implemented by their teachers' in an attempt to improve the cognitive and attitudinal outcomes of the students.

The five stage process on which the study is based combines theory and practice in providing the participating teachers with a structured means of bringing about change in their classrooms.

Students' perceptions of actual and preferred teacher interpersonal behaviour and the laboratory learning environment are measured using the QTI and SLEI respectively. Particular aspects of teacher interpersonal behaviour and the laboratory learning environment are targeted for change through the classroom environment improvement plans.

The study identified which aspects of the learning environment had changed after a period of intervention. It also identified associations between students' perceptions of aspects of their laboratory learning environment and attitudinal outcomes as well as associations between teacher interpersonal behaviours and attitudinal outcomes. While no direct associations were found between aspects of the laboratory learning environment or teacher interpersonal behaviours and cognitive outcomes, students' cognitive outcomes did improve over the duration of the study thus supporting a previously established link between student attitudes and cognitive outcomes.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

For a number of years, science teachers at one North Queensland secondary school have been concerned about the increasing number of students who do not obtain at least a sound level of achievement in junior science. While this situation is in itself an issue, it also seems to be having an impact on the number of students enrolling in senior biological science, chemistry and physics courses. Not wanting these subjects to disappear from the school curriculum offerings due to low enrolments, the issue of student outcomes in junior science needs to be addressed in order to improve these enrolment figures. This study addresses this issue by focusing on junior secondary science classrooms in this particular school, which has a student population of approximately 430.

1.2 BACKGROUND TO THE STUDY

Since the late 1960s, significant research, particularly by science educators, has been carried out which involves the conceptualisation, development, validation, and application of classroom environment instruments (Fraser, 1994; Fraser, 1986; Fraser & Walberg, 1991). One outcome of such research has been the finding of relationships between students' perceptions of science classroom learning environments and student attitude and achievement (Fraser, 1994; Fraser, 1991; Fraser, Walberg, Welch, & Hattie, 1987; McRobbie & Fraser, 1993).

A study by Wubbels (1993) which investigated the relationships between teacher-student interpersonal behaviour and student achievement and attitudes found that such behaviour is an important aspect of the learning environment, being closely related to student outcomes. It was also found that the relationship between curriculum and student outcomes was not particularly strong. These findings indicate that to improve student outcomes, the introduction of new curriculum

materials needs to be accompanied by changes in teacher behaviours. Students seem to achieve at higher levels in classes where they perceive teacher behaviours to result in increased cohesiveness, satisfaction and goal-directedness as well as decreased disorganisation and friction. Other studies (Henderson, 1995; Rawnsley, 1997; Wubbels, Brekelmans, & Hermans, 1987) also have highlighted links between students' perceptions of teacher-student interpersonal behaviour and student attitude and achievement. These studies have involved the use of the *Questionnaire on Teacher Interaction* (QTI) (Wubbels & Levy, 1991) or its revised version (Wubbels, 1993).

Given the concerns about student outcomes in junior science at the school previously referred to, combined with the fact that a new years 1 – 10 science syllabus was about to be implemented in Queensland schools, a study of learning environments seemed to be an appropriate starting point to identify teacher behaviour which may need to change in conjunction with the introduction of a new curriculum.

A key component of the 1999 Queensland Science Years 1 to 10 syllabus is *Working Scientifically* which is the term used to describe the practices and dispositions of science. When *Working Scientifically*, students make sense of the phenomena they experience as they investigate, understand and communicate through engagement in a wide range of active learning experiences. Implicit in this assortment of activities is laboratory work. It was therefore considered important that students' perceptions of the laboratory environment be a key element of the research.

In this study, two classroom environment instruments were used to obtain student perceptions about their junior science learning environments. The Questionnaire on Teacher Interaction (QTI) (Wubbels & Levy, 1993) was used to obtain information about student perceptions of teacher-student interpersonal behaviour and the *Science Laboratory Environment Inventory* (SLEI) (Fraser, Giddings, & McRobbie, 1995) was used to assess student perceptions of their laboratory learning environment. To allow for the identification of teacher-student interpersonal behaviours and laboratory practices that need to be changed, students responded to Actual and Preferred Forms of the two instruments.

1.3 AIM AND OBJECTIVES

1.3.1 Aim

The aim of this thesis was to document the processes utilised to facilitate changes to particular aspects of science classroom environments in a North Queensland secondary school, in conjunction with the introduction of a new curriculum, in order to improve student cognitive outcomes. This aim was operationalised into the objectives stated in Section 1.3.2. Future references to classroom environments or classroom learning environments in this thesis are intended to encompass both teacher interpersonal behaviour and the laboratory learning environment.

1.3.2 Objectives

The objectives of this thesis were:

1. to investigate students' perceptions of their actual and preferred science classroom and laboratory learning environments through the use of two instruments – the QTI and SLEI;
2. to identify specific teacher interpersonal behaviours, as perceived by students, that differ significantly from preferred behaviours;
3. to identify aspects of students' science laboratory learning environment that they perceive to be significantly different from their preferred environment;
4. to describe and evaluate an intervention process developed and implemented to reduce the disparity between students' actual and preferred perceptions of targeted teacher interpersonal behaviours from those identified in Objective 2 and targeted aspects of the science laboratory environment from those identified in Objective 3 and hence improve students' cognitive outcomes in science; and
5. to determine associations between students' cognitive outcomes, attitudinal outcomes and perceptions of their classroom and laboratory learning environments.

1.3.3 Research Question Origins

Research of any type involves the conducting of a study to answer one or more questions that inform the intent of the study. The research questions that this study seeks to provide answers to have been derived from the objectives stated earlier in this section. The research questions themselves are stated in Chapter 3.

1.4 RATIONALE FOR THE STUDY

As a science teacher, one continually strives to improve classroom practices in order to assist students maximise their outcomes. This study utilised a structured approach to improving students' outcomes that:

(i) identifies, through the use of the QTI and SLEI, aspects of the classroom environment that need to be changed;

(ii) involves a period of intervention during which teachers, working collaboratively to support each other, implement various strategies aimed at changing targeted aspects of their classroom environment;

(iii) documents the strategies implemented during the intervention process; and

(iv) assesses the success of the intervention through the readministration of the QTI and SLEI as well as monitoring changes in student outcomes. Student attitudes to junior science classes are also to be investigated after the period of intervention.

Because the period of intervention coincides with the implementation of a new science syllabus involving significant curriculum change, it is an opportune time to select strategies that support key features of the new syllabus as well as targeted aspects of the classroom environment.

Students are the key players in our classrooms and this study acknowledges their importance by using the QTI and SLEI to obtain their perceptions of actual and preferred teacher-student interpersonal behaviours and laboratory environments. Strategies are selected to bring about changes to targeted aspects of the classroom environment in order to improve student outcomes by moving student perceptions of actual classroom environments closer to their preferred classroom environments.

1.5 SIGNIFICANCE OF THE THESIS

It is not enough to collect data: something must be done with it (Freiberg & Stein, 1999). Herein lies the significance of this thesis – combining theory and practice.

Although considerable research has been conducted on students' perceptions of classroom learning environments, relatively little has been done to help teachers improve the environments of their own classrooms (Fraser, 1986; Fraser & Deer, 1983; Thorp, Burden, & Fraser, 1994; Yarrow, Millwater, & Fraser, 1997).

It might not always be possible to initiate reforms in classrooms simply by providing teachers with feedback about the manner in which students perceive the psychosocial environment (Jakubowski & Tobin, 1997). Research has shown teachers will only consider changing classroom environments when they see a need. They must take time to reflect on the feedback about aspects of their classroom environment and consider the implications for their students. If, as a result of this, they decide that it is important to attempt to change one or more aspects of their classroom environment a collaborative, structured approach which incorporates theoretical and practical components is more likely to result in desired changes.

In this study, teachers were provided with data that had been obtained from their classes. These data were interpreted with reference to previous research findings. Theory and practice were combined in an attempt to bring about changes to targeted aspects of their classroom environment. The proposed study became a reality when the teachers made a commitment to wanting to change aspects of their classroom environments after considering feedback about aspects of their classroom environment. While the researcher facilitated the structured process, the teachers themselves planned and implemented their classroom environment improvement plans thus taking on ownership of the process.

1.6 OVERVIEW OF METHODOLOGY

The approach selected was one which had been used successfully in studies cited by Fisher and Fraser (1990), Fraser (1994), Fraser (1989), Fraser and Deer (1983) and Fraser and Fisher (1986). It involved five basic steps as outlined below:

1. ASSESSMENT – Actual and Preferred Forms of the QTI and SLEI were administered to students.
2. FEEDBACK – responses were analysed and presented as profiles illustrating means of actual and preferred scores. Aspects of the classroom environment (teacher-student interpersonal behaviours and laboratory practices) that need to be changed in order to reduce major differences between the actual and preferred environment were identified.
3. REFLECTION AND DISCUSSION – the junior science teaching team reflected on and discussed the findings, thus clarifying the implications of the responses. Decisions were then made on which aspects of the classroom environment were going to be targeted for change. Justification for the need to change particular aspects of classroom environments was based on the implications of a study conducted by Wubbels (1993) and referred to previously in this chapter – to improve student outcomes, the introduction of new curriculum materials needs to be accompanied by changes in teacher behaviours.
4. INTERVENTION – teachers implemented the selected strategies, over a period of time, aimed at improving the specific aspects of the classroom environment that were targeted for change.
5. REASSESSMENT – the Actual Forms of the QTI and SLEI were administered again and responses analysed to determine whether or not there had been any perceived changes in the classroom environments. Junior science results were compared (starting prior to the beginning of the study and going through to the reassessment stage) to determine whether or not any improvement was obvious. Students also responded to a seven-item *Attitude to This Class* questionnaire.

Steps 1, 2 and 3 were carried out in 1996. 256 Year 8, 9 and 10 students from 12 classes responded to Actual and Preferred Forms of the QTI and SLEI. Step 4 took place over an extended period of time from 1997 to 2000. Implementation of the new science syllabus does not have to be completed until 2003. Step 5 took place in late 2000. This allows time for further intervention prior to complete syllabus implementation if reassessment indicates that this is required.

1.7 OVERVIEW OF THE THESIS

Chapter 1 describes the purpose of the study and provides background information which contextualises the study. Chapter 2 contains a review of the literature relating to learning environment research with particular attention being paid to studies which have investigated associations between learning environment variables and cognitive and attitudinal student outcomes in science, as well as those which have focused on reducing differences between students' perceptions of their actual and preferred learning environments in science.

In Chapter 3, the methodology utilised in this study is outlined with particular emphasis on the five-step process that is used in an attempt to improve targeted aspects of the classroom environment. Details of the use of the two classroom environment instruments used in this study (the QTI and the SLEI) are provided. Chapters 4 and 5 focus on the first four of the five steps of the study. In particular, Chapter 4 reports on the quantitative findings of the assessment stage and the resulting analyses and discussions that occurred in the feedback and reflection and discussion stages as well as the classroom environment improvement plans that were developed during the intervention stage. Chapter 5 deals with the qualitative information relating to these stages of the study. In Chapter 6 quantitative and qualitative data collected during the fifth stage of the study, the reassessment phase, are reported and analysed. Chapter 7 draws together the findings of the study in answering the research questions that framed the study. Also in this chapter the significance of the study is noted, limitations of the study discussed, directions for further research indicated and concluding remarks made.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter puts the study into context through its provision of a review of the literature which relates to the objectives stated in Chapter 1. The literature review is divided into four components. Firstly, the review documents research into classroom learning environments (Section 2.2). Approaches to studying such environments and the associated historical background to this research are outlined. The development of a number of learning environment instruments is described as well as their use in studying associations between students' cognitive and attitudinal outcomes and aspects of learning environments. In the second component of the review (Section 2.3), the focus is on the QTI. Its development and relationship with the model for interpersonal teacher behaviour is outlined. The reliability and validity of the QTI as a measuring device is discussed and a review of previous research studies that utilized it is carried out. The third component (Section 2.4) features the SLEI. The role of the laboratory in science curricula is considered and students' attitudinal and cognitive outcomes associated with their perceptions of the laboratory environment are reported on. The fourth component (Section 2.5) deals with the measurement of attitudinal outcomes. A summary concludes the chapter.

2.2 CLASSROOM LEARNING ENVIRONMENTS

The study of educational environments is commonly divided into two areas, one focusing on the school-level environment and the other on the classroom-level environment (Andersen, 1982; Fraser & Rentoul, 1982; Genn, 1984). The classroom environment is seen as the relationships between teachers and their students, or among students. The school environment involves a teacher's relationship with other staff, both teaching and non-teaching. Student and/or teacher perceptions are commonly used as a measure of the classroom environment whereas school

environment is usually assessed in terms of teacher perceptions. The current study uses student perceptions to assess classroom environments.

Educators often refer to the importance of a classroom's environment, climate, tone, atmosphere, ethos or ambience (Fraser, 1994). As well as being important in its own right, it is influential in terms of students' cognitive outcomes. Classroom environment research provides a means of monitoring, evaluating and modifying aspects of classroom environments to improve student outcomes.

2.2.1 Approaches to Studying Classroom Environments

An analysis of past reviews of research (Anderson, 1982; Fraser, 1991; Fraser 1998a; Fraser, 1998b; Fraser & Walberg, 1981; Templeton & Johnston, 1998; Wubbels, Creton, & Hooymayers, 1992) shows that, over more than three decades, studies involving the conceptualization, assessment and investigation of perceptions of various aspects of the classroom learning environment have established classroom environment research as a worthwhile and growing field of study. Classroom environments have been studied using techniques such as naturalistic inquiry, case study, ethnography and participant observation (Hamilton, Jenkins, King, MacDonald, & Parlett, 1977; Smith, 1978; Stake, 1978; Stake & Easley, 1978).

Systematic observation involving an external observer in methodical coding of classroom events has been widely used to study classroom environments (Dunkin & Biddle, 1974; Rosenshine & Furst, 1973). The literature (Jessor & Jessor, 1973) recognizes two distinct approaches to this type of study: the 'objective' approach of directly observing the environment and the 'subjective' approach based on the milieu inhabitants' apprehension of the environment. In order to distinguish between the environment assessed by the detached observer from the environment as perceived by the milieu inhabitants, Murray (1938) coined the terms *alpha press* to refer to an external observer's description of the environment and *beta press* as the perceptions of those within the environment.

Stern, Stein, and Bloom (1956) suggested that Murray's *beta press* could be broken into two further categories and used the terms *private beta press* to represent the

view that an individual student or teacher has of their classroom environment and *consensual beta press* to represent the shared view that students have as a group of participants in a classroom learning environment.

Pace and Stern's (1958) research popularized Murray's needs-press theory and provided an early example of the rigour of high-inference measures of educational environments. Rosenshine (1970) provided further clarification of the difference between low-inference and high-inference measures. He classified low-inference measures in a classroom as those involving an observer who recognised and recorded the occurrence of a set of predetermined events/actions/behaviours while high-inference measures involved a judgment or interpretation as to the extent to which certain events/actions/behaviours occurred. High-inference observations could be made by either a member of the classroom environment or an external observer. A problem associated with the use of an external observer is that because they are not part of the environment, their interpretations or judgments will be based on experiences external to the learning environment being studied.

The current use of quantitative assessment measures of classroom environments dates from the late 1960s and early 1970s when trends in observational and psychology studies in classrooms began to follow a similar path when each area of research recognized the importance of social-psychological constructs formed by students within their classroom environments. It was recognized that students' perceptions of the classroom environment impacted on their outcomes. In the last 40 years, significant attention has been paid to the development and use of instruments to assess the qualities of the classroom environment from the perspective of the student. Prior to this time, two techniques had dominated the study of classrooms and teaching – systematic observation of classrooms and naturalistic, ethnographic research. Both of these approaches conceptualized the teacher as a major determinant of the classroom environment but ethnography also recognized the importance of teacher-student interaction, seeking to report on, and interpret, the teachers' behaviour in the classroom.

High-inference measures of classroom environments are prevalent in classroom environment questionnaires. The value of high-inference measures was reviewed by

Chavez (1984) and Walberg and Haertel (1980) and the following advantages of using student perceptions as indicators of the quality of the classroom environment were highlighted in a number of studies (Biggs & Chopra, 1979; Fraser & Walberg, 1981; Fraser, 1994; Goldberg, 1968; Randhawa & Fu, 1973; Rosenshine, 1971; Walberg & Haertel, 1980):

1. Students are directly involved in classroom activities and observe more of the teacher's typical behaviour than does an outside observer. A teacher's behaviour is context-based and one teacher can exhibit different behaviours in different subject areas.
2. Students are more familiar with their teacher's idiosyncrasies that can be interpreted differently by an observer.
3. Students are in a better position to judge certain aspects of a teacher's behaviour than an external observer.
4. Students could observe aspects of the teacher's behaviour that the observer does not.
5. Students' perceptions of the classroom environment have been shown to account for a greater proportion of the variance in student outcomes than have directly-observed low-inference variables.
6. Perceptual measures are based on students' experiences over many lessons whereas observational data are usually restricted to a small number of lessons.
7. Perceptual measures involve the pooled judgments of all students in a class whereas observation techniques typically involve only a single observer.
8. Students' perceptions, because they are the determinants of student behaviour more than the real situation, can be more important than observed behaviours.
9. The use of trained observers over a period of time is more expensive and time-consuming than is the duplication, administration and scoring of questionnaires.
10. The presence of observers could alter aspects of the classroom environment.

Moos and Walberg, quite independently, pioneered a third approach to the study of the classroom environment which was based on the use of the perceptions of students and teachers about the classroom environment of which they were a part. Both

researchers identified similar measurable characteristics of the classroom environment.

2.2.2 Historical Background to Classroom Environment Research

Contemporary classroom environment research has evolved from the work of Lewin (1936) and Murray (1938) who established theoretical, conceptual and measurement foundations. To describe human behaviour, Lewin devised the formula B = f(P,E) where human behaviour (B) is a function of two interdependent influences – the person (P) and the environment (E). Lewin proposed this formula as a stimulus for new human behaviour research strategies (Stern, 1970). Murray, applying Lewin's theory, conceptualized the dual process of personal needs and environmental press (Moos, 1979). Murray (1938) defined 'needs' as the specific, innate personal requirements of an individual, as well as their desire to achieve them, as being determinants of an individual's personality. He defined as 'press' those environmental factors (outside the individual) that were beyond the control of an individual, but either facilitated or impeded the attainment of their personal needs. More specifically, Murray used the terms *alpha press* and *beta press* as described in Section 2.2.1. Murray's needs-press theory led to the development of various measures of personality but little consideration was given to environmental measures.

As a result of the work of Moos (1974), the classroom environment can be depicted as an organizational framework. From his studies of a variety of human environments Moos identified three basic types of dimensions that are characteristic of all human environments. The *relationship* dimensions identify the nature and intensity of personal relationships within the environment and assess the support and involvement of people within the environment. The *personal development* dimensions assess the way personal growth and self-enhancement tend to occur while the *system maintenance* and *system change* dimensions measure the extent to which the environment is orderly, clear in expectations, controlled and responsive to change.

Walberg (1976, 1981, 1982) also recognized the importance of the environment as he developed his theory of educational productivity (Walberg, 1984, 1986) which states that there are nine factors which contribute to variance in students' cognitive and affective outcomes. These are: student ability, age and motivation; the quality and quantity of instruction; and the psychological climate of the home, the classroom social group, the peer group outside the classroom and the mass media. Testing of the model using data collected as part of national studies (Walberg, 1986; Walberg, Fraser, & Welch, 1986) has confirmed its validity in showing that student achievement and attitudes are influenced by a number of factors rather than by one dominant factor. Classroom and school environmental factors were found to be particularly influential on student outcomes, even when numerous factors were controlled.

2.2.3 The Development of Classroom Environment Instruments

As a result of Moos previous work in psychiatric hospitals (Moos & Houts, 1968) and correctional institutions (Moos, 1968) he developed and refined what is now known as the *Classroom Environment Scale* (CES), (Moos & Trickett, 1974; Trickett & Moos, 1974). Concurrently, Walberg developed the *Learning Environment Inventory* (LEI), (Anderson & Walberg, 1968; Fraser, Anderson, & Walberg, 1982; Walberg, 1968). These two instruments are still in use today and have been the basis for the development of a number of similar instruments. These instruments all share a common conceptualization of the classroom environment as a dynamic social system but each focuses on aspects of the environment which are perceived by its developers to be most relevant to its intended purpose. Some of these instruments are briefly reviewed in Table 2.1. In addition to the classroom environment instruments reviewed in Table 2.1, numerous other instruments have been developed. In general, these have utilized scales and items from existing instruments to create modified instruments which are tailored to particular research purposes and contexts. The scales used in all these instruments can be categorized into one of the dimensions of Moos' scheme for classifying human environments. Each of these instruments has been trialed extensively, statistically analysed and

Table 2.1

Summary of Classroom Environment Instruments

Instrument	Background Information and References	No. of Scales	No. of Items/ Scale	Total No. of Items	Response Format	Scales	Moos Dimension Classification		
							Relationship	Personal	System Maintenance and Change
Learning Environment Inventory (LEI)	Developed in the late 1960's (Anderson & Walberg, 1968) and measures student perceptions of 15 environment dimensions of secondary school classrooms which had previously been identified as good predictors of learning and were relevant to social psychological theory of the time (Fraser & Walberg, 1991).	15	7	105	4 point Likert-type scale, some items reverse scored	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy Speed Difficulty Competitiveness Diversity Formality Material Environment Goal Direction Disorganisation Democracy	✓ ✓ ✓ ✓ ✓ ✓	 ✓ ✓ ✓	 ✓ ✓ ✓ ✓ ✓ ✓

Instrument	Background Information and References	No. of Scales	No. of Items/ Scale	Total No. of Items	Response Format	Scales	Moos Dimension Classification		
							Relationship	Personal	System Maintenance and Change
Science Laboratory Environment Inventory (SLEI)	Developed specifically to assess science laboratory learning environments at the senior secondary or tertiary levels (Fraser, Giddings & McRobbie, 1991). Because of its relevance to this study, the SLEI will be discussed in more detail in Section 2.4.	5	7	35	5 point Likert-type scale	Student Cohesiveness Open-endedness Integration Rule Clarity Material Environment	✓	✓ ✓	 ✓ ✓
My Class Inventory (MCI)	A simplified version of the LEI intended for use with primary school students so the language is simpler than in the LEI (Anderson & Walberg, 1968; Fraser, Anderson & Walberg, 1982; Walberg & Anderson, 1968). The original version contained 45 items but this was reduced to 38 items (Fisher & Fraser, 1981). A short 25 item version is also available.	5	6 - 9	38	Yes/No	Cohesiveness Friction Satisfaction Difficulty Competitiveness	✓ ✓ ✓	 ✓ ✓	
Classroom Environment Scale (CES)	Developed by Moos (Moos, 1974; Moos, 1979; Moos & Trickett, 1987; Trickett & Moos, 1973). It was primarily developed to examine the psychosocial environment of school classrooms from the perspective of participant interaction (Raviv, Raviv & Reisel, 1990).	9	10	90	True/False, half items reverse scored	Involvement Affiliation Teacher Support Task Orientation Competition Order & Organisation Rule Clarity Teacher Control Innovation	✓ ✓ ✓	 ✓ ✓	 ✓ ✓ ✓ ✓

Instrument	Background Information and References	No. of Scales	No. of Items/ Scale	Total No. of Items	Response Format	Scales	Moos Dimension Classification		
							Relationship	Personal	System Maintenance and Change
Individualised Classroom Environment Questionnaire (ICEQ)	Developed by Rentoul and Fraser (1979) and assesses those dimensions which distinguish individualized classrooms from conventional ones. A feature of the ICEQ is that there is also a short form that retains the five scales but has only 5 items per scale rather than the 10 in the long version (Fraser, 1990). These items retain the same proportion of positively and negatively worded items.	5	10	50	5 point Likert-type scale, some items reverse scored	Personalisation Participation Independence Investigation Differentiation	✓ ✓	 ✓ ✓	 ✓
Questionnaire on Teacher Interaction (QTI)	Assesses interpersonal teacher behaviour from a systems communication perspective, which assumes that teachers and students mutually influence each other's behaviour (Creton, Wubbels & Hooymayers, 1993, Wubbels, Brekelmans & Hooymayers, 1991). A more economical 48-item version has been developed and validated (Goh & Fraser, 1996). Due to its relevance to this study, the QTI will be discussed in greater detail in Section 2.3.	8	8	64	5 point Likert-type scale	Helpful/Friendly Understanding Dissatisfied Admonishing Leadership Uncertain Strict Student Responsibility	✓ ✓ ✓ ✓		 ✓ ✓ ✓ ✓

Instrument	Background Information and References	No. of Scales	No. of Items/ Scale	Total No. of Items	Response Format	Scales	Moos Dimension Classification		
							Relationship	Personal	System Maintenance and Change
Constructivist Learning Environment Survey (CLES)	Designed to assist researchers and teachers assess the degree to which a particular classroom's environment is consistent with a constructivist epistemology (Taylor, Fraser & Fisher, 1997). In their use of the CLES, Taylor, Fraser & White (1994) arranged the items in groups of like items. This meant that all of the items for a particular scale ended up in the same group. This was a change from the traditional approach to instrument design which utilized a cyclic arrangement of scale items.	5	6	36	5 point Likert-type scale	Critical Voice Mathematical Uncertainty Negotiation Personal Relevance Shared Control	✓	✓ ✓ ✓	✓
College and University Classroom Environment Inventory (CUCEI)	Developed specifically to investigate the learning environment of university and college classes containing up to 30 students (Fraser & Treagust, 1986; Fraser, Treagust & Dennis, 1986). Its dimensions have been adapted from other instruments and reflect the greater degree of individualized work expected in tertiary classrooms.	7	7	49	4 point Likert-type scale, about half items reverse scored	Personalisation Involvement Student Cohesiveness Satisfaction Task Orientation Innovation Individualism	✓ ✓ ✓ ✓	✓	✓ ✓
Geography Classroom Environment Inventory (GCEI)	Despite its name, was specifically designed to assess innovation and gender equity in computer assisted learning environments in Singapore (Teh & Fraser, 1993; 1995)	4	8	32	5 point Likert-type scale, almost half items reverse scored	Gender Equity Investigation Innovation Resource Adequacy	✓	✓	✓ ✓

Instrument	Background Information and References	No. of Scales	No. of Items/ Scale	Total No. of Items	Response Format	Scales	Moos Dimension Classification		
							Relationship	Personal	System Maintenance and Change
Computer Classroom Environment Inventory (CCEI)	Developed to assess student perceptions of learning environments which involve both inquiry learning methods and the use of computer-aided instruction (Maor & Fraser, 1993; 1996).	5	6	30	5 point Likert-type scale, some items reverse scored	Satisfaction Investigation Open Endedness Material Environment Organisation	✓	✓ ✓	 ✓ ✓
Cultural Learning Environment Questionnaire (CLEQ)	Developed to assess the culturally sensitive factors of the classroom learning environment (Waldrip & Fisher, 1997). Based partly on existing instruments.	8	5	40	5 point Likert-type scale	Gender Equity Collaboration Risk Involvement Competition Congruence Teacher Authority Modeling Communication	✓ ✓ ✓	 ✓ ✓	 ✓ ✓ ✓
What is happening in this Class (WIHIC)	A relatively new questionnaire which makes use of scales from past instruments to enhance its coverage of contemporary educational thought (Fraser, Fisher & McRobbie, 1996).	7	8	56	5 point Likert-type scale	Student Cohesiveness Teacher Support Involvement Investigation Task Orientation Cooperation Equity	✓ ✓ ✓	 ✓ ✓ ✓	 ✓

Instrument	Background Information and References	No. of Scales	No. of Items/ Scale	Total No. of Items	Response Format	Scales	Moos Dimension Classification		
							Relationship	Personal	System Maintenance and Change
Distance and Open Learning Environment Survey (DOLES)	Developed to meet a growing need for research into university distance education settings (Jegede, Fraser & Fisher, 1998). * denotes optional scales.	5 (+2)	8 (6)	40 (+12)	5 point Likert-type scale	Teacher Cohesiveness Teacher Support Personal Involvement & Flexibility Task Orientation & Material Environment Technology Resources *Study Centre Environment *Home Environment	✓ ✓ ✓	 ✓ ✓	 ✓ ✓
Socio-Cultural Environment Scale (SCES)	Developed to assess student perceptions of the socio-cultural environment of their classrooms (Jegede & Okebukola, 1988). Its development was facilitated by a panel of experts in African studies comprised of science educators, science teachers, sociologists and anthropologists.	5	6	30	3 point Likert-type scale	African World View Societal Expectation Authoritarianism Goal Structure Sacredness of Science	✓	 ✓	 ✓ ✓ ✓

Source: Developed from Fraser, 1998a

refined so that researchers can be confident of the reliability and discriminant validity of the measures. This aspect of the development of each instrument is not reviewed here but is covered in references provided for each instrument.

A common characteristic of many classroom environment instruments is to have several forms of the one instrument, as described below:

(a) Actual and Preferred Forms – the 'actual' form requires the respondent to provide perceptions of the environment they are currently part of while the 'preferred' form requires them to provide their perceptions of what they would prefer the environment to be like. The availability of these two forms allows researchers (including teachers) to compare student perceptions of actual and preferred classroom environments and identify discrepancies between them. Profiles of classrooms using these two forms of an instrument consistently show higher ratings for the preferred environment (Fraser, 1986; Moos & Trickett, 1987). The discrepancy between the two sets of results can provide a useful starting point for reflecting on teacher practice and be the basis of intervention treatment by the teacher (Fisher, 1992; Fraser, 1981a; Fraser & Fisher, 1986; Fraser, Malone, & Neale, 1989).

(b) Student and Teacher Forms – some studies seek the perceptions of teachers about their classroom environments and so the wording of items on some instruments has been changed to cater for this thus producing a 'teacher' version. In some cases, students and teachers respond to the same version of an instrument. However, a discrepancy often occurs when teachers and students profile the same classroom environments. Early in their research, Moos and Trickett (1974) noted that teachers consistently see their classes in a more favourable light than do their students. Research by Haladyna and Shaughnessy (1984) into the way in which teachers view their classroom environment led them to a more extreme conclusion. They commented, "Therefore we can conclude with some assurance that there is substantially no relationship between teacher's and student's judgments of their learning environments … teacher judgments of the learning environments are questionable" (p. 13). Nevertheless, profiling student and teacher perspectives of the

classroom environments together can be a useful way for teachers to understand and improve their classroom interactions.

(c) Long and Short Forms – for some instruments (CES, MCI, ICEQ, QTI) a version called a 'short' form has been produced. On these forms, the number of items is reduced to approximately 25. This means that less class time is required for students to respond to them and they are hand scorable, reducing data preparation time.

(d) Class and Personal Forms – a 'class' form measures the respondents perceptions of the class as a whole while the 'personal' form measures their perceptions of their role within the class. These two forms of an instrument are identical except for the focus of each statement. The need for a 'personal' form of classroom environment instruments was first identified by Fraser and Tobin (1991) who suggested that it would be useful as a measure of students' perceptions of their specific interaction with the classroom learning environment. They also suggested it would be more useful than the 'class' form for exploring subpopulations amongst students.

2.2.4 Past Research Using Classroom Environment Instruments

In order to illustrate the wide range of applications of classroom environment instruments, Fraser (1998b) identified 12 lines of past research involving their use. They were:

* associations between student outcomes and the classroom environment
* teachers' practical attempts to improve their classroom environments
* whether students achieve better when in their preferred classroom environment
* combining qualitative and quantitative methods
* evaluation of educational innovations
* differences between students' and teachers' perceptions of the same classrooms
* school psychology
* links between educational environments
* cross-national studies

* transition from primary to secondary education
* teacher education
* teacher assessment.

The first four lines of research referred to in the list have particular relevance to this study and are considered in more detail below.

2.2.4.1 Associations between Student Outcomes and Classroom Environment

The predominant focus of past classroom environment research has involved investigations of associations between students' cognitive and affective learning outcomes and their perspectives of psychosocial characteristics of their classrooms (Fraser, 1998b). Fraser's (1994) tabulation of 40 past studies illustrates that associations between outcome measures and classroom environment perceptions have been replicated for a variety of cognitive and affective outcome measures using a number of different classroom environment instruments and a variety of samples, across a range of different countries and grade levels.

Past studies of interpersonal teacher behaviours have indicated that this important element of the learning environment is strongly related to student outcomes. A study conducted among Australian science and mathematics teachers found that those teachers emphasizing leadership, friendly and understanding behaviours were more likely to promote student achievement. It was also found that those teachers who were perceived as less strict were more likely to promote more positive attitudes, whilst those who were perceived as more strict were likely to promote better achievement (Wubbels, 1993).

The findings from prior research are highlighted in the results of a meta-analysis involving 734 correlations from a collection of 12 studies of 10 data sets from 823 classes in eight subject areas containing 17,805 students in four nations (Haertel, Walberg, & Heartel, 1981). Learning post-test scores and regression-adjusted gains were found to be consistently and strongly associated with cognitive and affective learning outcomes, although correlations generally were higher in samples of older students and in studies employing collectivities such as classes and schools (in

contrast to individual students) as the units of statistical analysis. In particular, better achievement on a variety of outcome measures was found consistently in classes perceived as having greater cohesiveness, satisfaction, and goal direction, and less disorganisation and friction. Other meta-analyses synthesized by Fraser, Walberg, Welch, and Hattie (1987) provide further evidence supporting the link between educational environments and student outcomes.

Fraser and Fisher (1982) reported a study of the effects of classroom environment on student outcomes involving a representative sample of 116 Grade 8 and 9 science classes, each with a different teacher, in 33 different schools. Three cognitive and six affective measures were administered both at the beginning and end of the same school year. In addition, information was gathered about student general ability. Overall, the study yielded consistent support for the existence of outcome-environment relationships and suggested some important tentative implications for educators wishing to enhance students' achievement by creating classroom environments found empirically to be conducive to achievement. For example, practitioners are likely to find useful the finding that order and organisation seemed to have a positive influence on student achievement of a variety of aims.

From Fraser, Giddings, and McRobbie's (1992) research involving use of the SLEI in science laboratory classroom environments, the most striking finding was that both cognitive and affective outcomes were superior in situations in which integration (links between the work covered in laboratory classes and theory classes) was greater.

Literature reviews (Fraser, 1986, 1994; Fraser & Walberg, 1991) show that science education researchers have been world leaders in the field of classroom environment research for more than a quarter of a century. It has been demonstrated internationally that students' perceptions of the science classroom learning environment have been positively associated with students' cognitive outcomes and students' attitude to class (Fraser, 1991; Fraser, 1994; Fraser, Walberg, Welch, & Hattie, 1987; Haertel, Walberg, & Haertel, 1981; McRobbie & Fraser, 1993). If education is to improve student outcomes and increase the interest of students in science, these associations need to be considered. This statement is of key

significance in relation to the current study. This study (as indicated in Chapter 1) arose from an identified need to improve students' cognitive outcomes in science as well as increasing student interest thus encouraging them to continue their studies of science into the senior school. Its focus has been the use of student perceptions of two aspects of their science classroom environments – teacher interpersonal behaviour and the laboratory environment, to identify features of the classroom environment which need to be modified in order to improve students' cognitive and attitudinal outcomes.

The promotion of positive attitudes towards science is seen as a major aim of science education. Mager (1968) outlined three reasons for promoting positive attitudes in students. First, research has indicated associations between positive attitudes and enhanced academic achievement. Second, a positive attitude is more likely to sustain interest in the field of study in the future. Third, peers are influenced by the attitudes of others. Shulman and Tamir (1972) suggested that affective outcomes of education are at least as important as cognitive outcomes. Acknowledgement of their importance is reflected in their increasing emphasis in curricula (Mathews, 1974; Hough & Piper, 1982).

2.2.4.2 Teachers' Practical Attempts to Improve their Classroom Environments

Feedback based on student or teacher perceptions has been utilized in a five-step process as a basis for reflecting upon, discussion of, and systematic attempts to improve classroom environments at a variety of different levels of education (Fisher, Fraser, & Bassett, 1995; Fraser & Deer, 1983; Fraser, Docker, & Fisher, 1988; Fraser, Seddon, & Eagleson, 1982; Thorp, Burden, & Fraser, 1994; Woods & Fraser, 1996; Yarrow & Millwater, 1995; Yarrow, Millwater, & Fraser, 1997;). The five basic steps are outlined below:

1. Assessment – all students in the class respond to the Preferred Form of a classroom environment instrument, and one week later to the Actual Form of the same instrument.
2. Feedback – the teacher is provided with feedback information derived from student responses in the form of profiles representing the class mean of

students' actual and preferred environment scores. These profiles permit identification of the changes in the classroom environment needed to reduce major differences between the nature of the actual classroom environment and that preferred by students, as perceived by students.

3. Reflection and Discussion – the teacher engages in private reflection and informal discussion about the profiles in order to provide a basis for a decision about whether an attempt would be made to change the environment in terms of some of the dimensions. The main criteria used for selection of dimensions for change are that there should be a sizeable actual-preferred difference on that variable and that the teacher should feel concerned enough about this difference to want to make an attempt to reduce it.
4. Intervention – the teacher introduces an intervention of approximately two months' duration in an attempt to change the classroom environment.
5. Reassessment – the student actual form of the scales is re-administered at the end of the intervention to see whether students are perceiving their classroom environments differently than before.

Woods and Fraser (1995) used this basic approach to improving classroom environments with 16 teachers who used the actual and preferred forms of the *Classroom Interaction Patterns Questionnaire* to assess student perceptions of teacher behaviours (praise and encouragement, open questioning, lecture and direction, individual work, discipline and management, and group work). Whereas half of the teachers received feedback and attempted changes in their classrooms, the other half only administered the questionnaires. Teachers who received feedback, compared with those who didn't, were able to achieve more reductions in actual-preferred discrepancies on most of the classroom environment dimensions.

In another application of this approach to improve classroom environments, the short 24-item version of the CES was used. The class involved in the study consisted of 22 grade 9 boys or girls of mixed ability studying science at a government school in Tasmania, Australia (Fraser & Fisher, 1986). The results of the study showed that some change in student perceptions of the actual learning environment occurred during the time of intervention. Pretest-posttest differences were statistically significant only for teacher support, task orientation, and order and organisation.

These findings were noteworthy because two of these dimensions were the ones targeted by the teacher to attempt change (there appears to have been a side affect of the intervention that may have resulted in the classroom becoming more task oriented than students would have preferred). This case study, in conjunction with other previous studies (Fraser & Fisher, 1986), suggests the potential usefulness of teachers employing classroom environment instruments to provide meaningful information about their classrooms and a tangible basis to guide improvements in classroom environments.

A three phase study (Fraser, Sinclair, & Ledbetter, 2001) involving ten middle grade teachers and their 43 classes of students in an urban North Texas school setting confirmed that teachers who receive support and training can use feedback based on students' viewpoints to improve their classroom environments. Actual and preferred forms of the *Inventory of Classroom Environments* (ICE) were administered to students. The actual and preferred environments of different classes were described using profiles of classroom environment scores. Three teachers from the original sample attempted to improve their classroom environments. Based on the questionnaire results, each teacher developed their own action plan in an attempt to alter their classroom environment. Each teacher targeted classroom environment changes in a particular gender group.

The phase of the study related to changing classroom environments utilized a method adapted from the one previously described in this thesis. Reassessment of the students' perceived environment using the ICE showed that changes had occurred in the classrooms of the three teachers on the ICE dimensions they had targeted for improvement.

In addition, an important insight gained from the study was that, in classes where males and females have distinctly different perceptions of the actual and preferred classroom environment, environmental change attempts need to involve different interventions for students of different genders.

One of the aims of a study conducted by Wanpen and Fisher (2004) was to improve the learning environment in a tertiary level computer classroom in Thailand by

making it more constructivist as well as more collaborative. The study followed the steps of: assessment, feedback, reflection and discussion, intervention and re-assessment (Fraser, 1999b). In the assessment stage, the actual and preferred forms of the *Constructivist Learning Environment Survey* (CLES) were administered to a class of 29 students undertaking a computer course emphasizing the use of applications. Feedback was provided in the form of profiles constructed using class mean scores from student responses to the actual and preferred versions of the CLES. In the reflection and discussion stage a decision was made on which CLES scales to attempt to change and a classroom environment improvement plan developed. The implementation of strategies to bring about changes formed the intervention stage. At the end of the intervention, the actual form of the CLES was re-administered to determine whether the students perceived their actual environment differently.

Analysis of the data collected during the assessment stage showed that statistically significant differences existed between student perceptions of the actual and preferred classroom environment for all five scales of the CLES, namely, Personal Relevance, Uncertainty, Critical Voice, Shared Control and Student Negotiation. Each of these scales represented one aspect of the constructivist learning environment and it was decided to attempt to improve all five. The classroom environment improvement plan dealt with each of the five dimensions separately, outlining the strategies that were used in the attempt to better align the actual and preferred classroom environment as perceived by students.

The results of the re-assessment stage indicated that students perceived their learning environment improved on all five aspects. Qualitative results obtained from reflective journals kept by students added to the picture on how they viewed their own learning and the learning environment on aspects that were not addressed by the CLES. They also reflected the quantitative results.

A modified version of this five-step process was used in the current study. Details of the actual process used are provided in Chapter 3.

2.2.4.3 Whether Students Achieve Better When in their Preferred Classroom Environment

Using both Actual and Preferred Forms of classroom environment instruments provides a means of investigating whether students achieve better when there is a higher similarity between the actual classroom environment and that preferred by students. By using a person-environment interaction framework, it is possible to investigate whether student outcomes depend, not only on the nature of the actual classroom environment, but also on the match between students' preferences and the actual environment (Fraser & Fisher, 1983a, 1983b; Wong & Watkins, 1996). Using the ICEQ with a sample of 116 class means, Fraser and Fisher's study involved the prediction of post-test achievement from pre-test performance, general ability, the five actual individualization variables and five variables indicating actual-preferred interaction. The practical implication of the findings is that class achievement of certain outcomes might be enhanced by changing the actual classroom environment in ways which make it more congruent with that preferred by the class.

Byrne, Hattie, and Fraser (1986) and Hattie, Byrne, and Fraser (1987) reported that achievement (in English and Mathematics) was more highly correlated with students' perceptions of their 'actual' learning environment than with their 'preferred' environment. It follows then, that if differences between 'actual' and 'preferred' environments are minimized students should achieve at a higher level.

2.2.4.4 Combining Qualitative and Quantitative Methods

A number of educational researchers have claimed that there are merits in moving from the either/or situation to research which involves combining quantitative and qualitative methods (Cook & Reichardt, 1979; Firestone, 1987; Fraser, 1988; Howe, 1988; Smith & Fraser, 1980). The field of learning environment research offers a wide variety of questionnaires which have been developed to quantify students' perceptions of many different aspects of classroom environments (Fraser, 1998a). Similarly there is a variety of qualitative methods for studying the learning environment, including interviews, discussions and observations (Frieberg & Stein, 1999).

Although the distinction between qualitative and quantitative methods is sometimes blurred (Linn, 1986), the two methods are sufficiently distinct that combining them in a research study can provide a more complete picture of the classroom environment (Fraser, 1994). Examples of such studies include those of Fraser and Tobin (1991), Garcia (1990), Tobin and Fraser (1990) and Tobin, Kahle, and Fraser (1990).

Each method, quantitative and qualitative, makes a distinct contribution to the assessment of the classroom environment (Fraser, 1986; Tobin & Fraser, 1998). Any research method provides just one possible window into educational environments (Fraser, 1998a). There are strengths and advantages to each approach. Quantitative data enable standardized, objective comparisons and permit overall descriptions of situations in a systematic and comparable way (Punch, 1998). When a study using quantitative methods has been completed, the main findings can be contextualised through observations and verbal accounts from participants (Tobin & Fraser, 1998).

Aldridge and Fraser (2000) conducted a study that used multiple research methods. The study compared classroom environments in Taiwan and Australia. Quantitative data were collected through the administration of learning environment and attitude questionnaires while qualitative data collection methods involved observation, interviews and narrative stories. The data collected using different methodologies complemented each other and provided a more comprehensive picture of the learning environments in each country.

Roth (1998), in his research design to facilitate reform of science teaching, combined quantitative and qualitative results. The quantitative results expressed the overall trends, while the qualitative results helped the researchers gain further understanding of the relationship between students' perceptions of the learning environment and achievement.

In one interpretive study of two science teachers, Tobin, Kahle, and Fraser's (1990) use of a classroom environment questionnaire showed that the student-perceived classroom environment was related to the teachers' knowledge and beliefs. Differences in teacher expectations and attitudes toward individual students were

reflected in differences in individual students' perceptions of the learning environment. By drawing on a qualitative data base, the teacher-researcher was able to provide some insight into why the results are consistent and plausible. For example, the high level of perceived personal relevance in one class was consistent with this teacher's practice of devoting one science lesson per week to things that were of personal interest to her students.

Through triangulation of qualitative data and quantitative information, greater credibility can be placed on the findings (Fraser & Tobin, 1991; Tobin & Fraser, 1998). In order to maximize the strengths inherent in each approach, both qualitative and quantitative methods have been utilized in the current study.

The QTI and the SLEI were the classroom environment instruments used in this study and they are the focus of Sections 2.3 and 2.4 , respectively, of this chapter. Specific examples of past studies in which they have been used will be provided in these sections.

2.3 THE QUESTIONNAIRE ON TEACHER INTERACTION (QTI)

One particular aspect of the classroom environment is the relationship between the teacher and the student. A number of studies carried out in the Netherlands (Brekelmans, 1989; Wubbels, Creton, & Hooymayers, 1985) recognized the importance of teacher-student interpersonal relationships in the classroom. Brekelmans, Wubbels, and Creton (1990) used the term 'interactional teacher behaviour' and defined this as "behaviours that concern the relationships between the teacher and the students and that are expressed in the interaction between the persons communicating in the classroom" (Brekelmans, Wubbels, & Creton, 1990, p. 336). Wubbels and his colleagues went on to conceptualise, and ultimately develop an instrument for measuring, the teacher-student interpersonal relationships in the classroom.

2.3.1 A Model for Interpersonal Teacher Behaviour

Wubbels, Creton, and Holvast (1988) investigated teacher behaviour in classrooms from a systems perspective, adapting a theory on communication processes developed by the Palo Alto group which included Waltzlawick, Beavin, and Jackson (1967). The notion of circularity, a central concept in the systems theory of communication, suggests that "changes in one part of the system lead to changes in other parts of the system, which influence the first part, and so on" (Wubbels, Creton, & Holvast, 1988, p. 26). Within this perspective of the theory it is assumed that the behaviours of participants mutually influence each other – the behaviour of the teacher is influenced by the behaviour of the students and in turn influences the behaviour of the students. With this system perspective in mind, Wubbels, Creton, and Hooymayers (1985) developed a model to map interpersonal teacher behaviour using an adaptation of the work of Leary (1957).

According to Leary's model of interpersonal behaviour, all interpersonal behaviour is motivated by an individuals need to reduce anxiety and maintain self-esteem and conceptualized on two primary dimensions. One of these is the Influence dimension, measuring dominance and submissiveness, while the other is the Proximity dimension which measures the degree of cooperative or oppositional behaviour. If an individual repeats interpersonal behaviours which reduce anxiety and maintain or boost self-esteem then a pattern of communication behaviour is established. This enhances the link with the systems perspective that suggests that circular communication processes develop which not only consist of behaviour but determine behaviour as well (Creton, Wubbels, & Hooymayers, 1993).

Leary's model also provides a framework for measuring specific interpersonal behaviours. Leary and his co-workers identified sixteen categories of interpersonal behaviour and Leary (1957) mapped them onto a two-dimensional coordinate system. The degree of cooperation between individuals communicating was mapped on the horizontal axis. This continuum was labeled the 'Affection – Hostility' axis and represents the Proximity dimension. The degree of control or influence over the communication process of the communicator being observed is mapped on the vertical axis which represents the Influence dimension, the continuum being labeled

'Dominance – Submission'. The Leary model has been validated many times in psychological research settings and the dimensions of proximity and influence have been widely accepted as universal indicators of human interpersonal behaviour (Wubbels, Creton, & Hooymayers, 1992).

2.3.2 Development of the QTI

In the development of the QTI, the Leary model was modified and interpersonal teacher behaviour mapped using a Proximity dimension (Cooperative, C – Opposition, O) and an Influence dimension (Dominance, D – Submission, S) as shown in Figure 2.1.

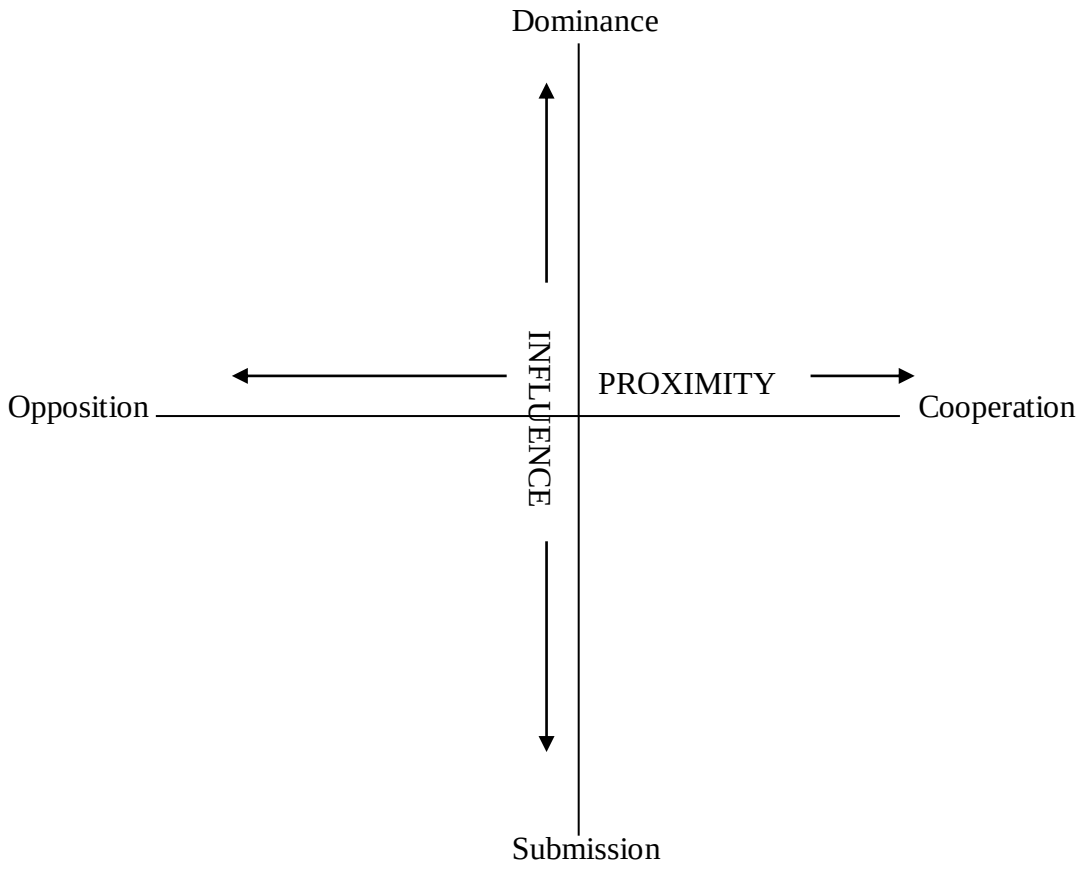

Figure 2.1. The two-dimensional basis of the QTI.
Source: Wubbels & Levy (1993)

These dimensions can be represented as a coordinate system divided into eight sectors, each of which describes a particular type of teacher behaviour: Leadership (DC), Helping/Friendly (CD), Understanding (CS), Student Responsibility/Freedom (SC), Uncertain (SO), Dissatisfied (OS), Admonishing (OD) and Strict (DO) (Wubbels, Brekelmans, & Hooymayers, 1991). The first letter in the code assigned to each sector represents which of the two dimensions in that quadrant dominate. For example, in the opposition Submission/Opposition quadrant, when submission is dominant over opposition the interpersonal behaviour is coded as SO and referred to as uncertain while when opposition dominates over submission the behaviour is coded as OS and described as dissatisfied. Typical behaviours for each sector are shown in Figure 2.2.

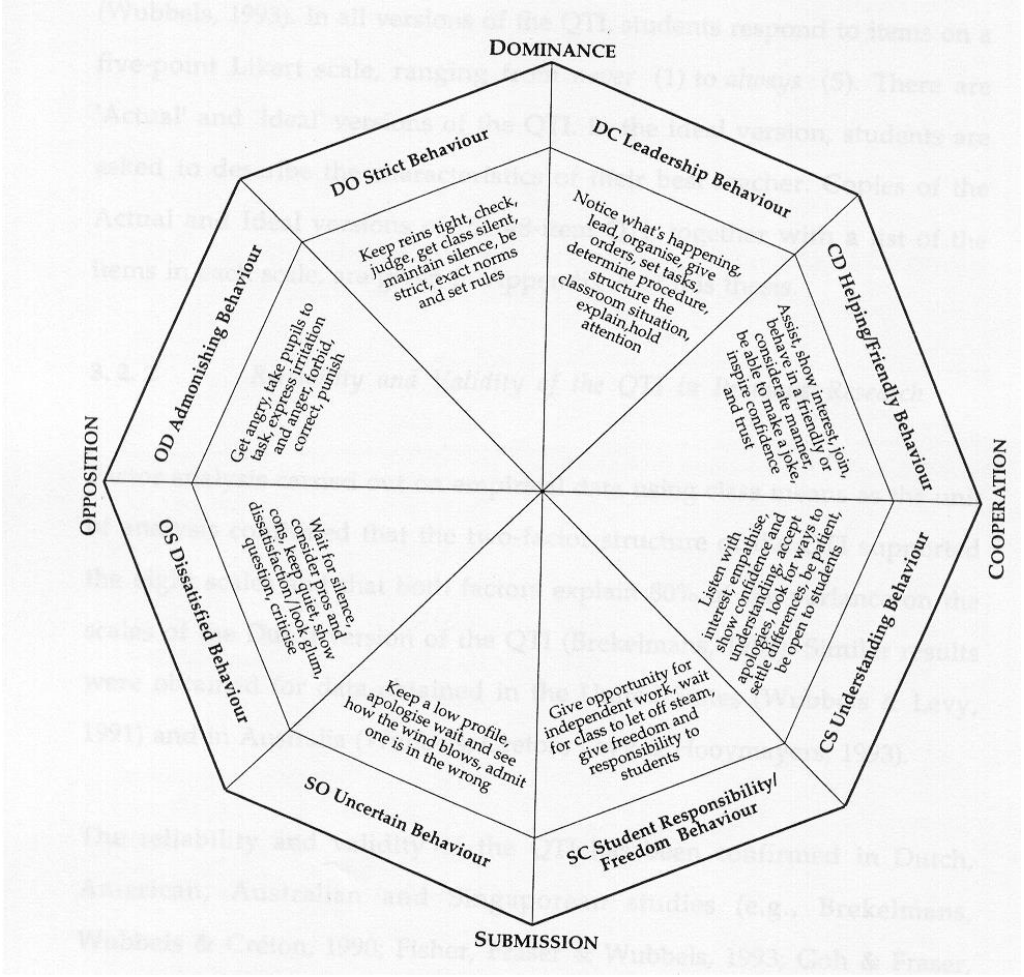

Figure 2.2. The model for interpersonal teacher behaviour.
Source: Fisher, Fraser, & Wubbels (1993)

The QTI (Wubbels & Levy, 1991; 1993) was designed to assess teacher-student interpersonal behaviour in the lower secondary classroom and developed out of the need to measure secondary students' and teachers' perceptions of teacher behaviour. The original version developed in The Netherlands took the form of a 77-item, 8-scale questionnaire in the Dutch language (Wubbels, Brekelmans, & Hermans, 1988). The number of items in each scale varied from nine to eleven. This version of the QTI was the result of a modification, rewording and reduction of the 128 items of Leary's *Interpersonal Adjective Checklist* (ICL) (Wubbels, Creton, Levy, & Hooymayers, 1993). Another significant change was the modification of the result format from a "yes" or "no" response in the ICL to a five point Likert-type response. The items were arranged into eight scales corresponding to the eight sectors of the model for interpersonal behaviour. An American version (Wubbels & Levy, 1991) has the same 8 scales but contains 64 items while an Australian version (Fisher, Fraser, Wubbels, & Brekelmans, 1993) has 48 items. In all versions of the QTI students respond to items on a five-point Likert scale, ranging from 0 (never) to 4 (always). There are 'actual' and 'preferred' forms of the QTI. In the 'preferred' form, students are asked to describe the characteristics of their best teacher while in the 'actual' version they are asked to describe the characteristics exhibited by their current teacher. Student perception scores are averaged to give a class mean score in each of the dimensions. Studies (Brekelmans, 1989; Wubbels & Levy, 1993) have shown that student perceptions of their teacher's interpersonal behaviour do not vary significantly once the predictable pattern of behaviour has become stable, usually after two months. They also show that 10 students in a class is a sufficient number to yield reliable data at the class level. There are also teacher versions of the QTI where teachers provide their perceptions of their own behaviour as well as behaviour which they consider to be ideal. The wording of teacher versions varies slightly from student versions. Table 2.2 clarifies further the nature of the QTI by providing a scale description and sample item for each of the eight scales from teacher and student preferred and actual forms of the 48-item Australian version of the QTI.

A copy of the Student form of the 48-item Australian version of the QTI can be found in Appendix A of this thesis.

Table 2.2

Description of Scales and Sample Items for each Scale and Form of the QTI

Scale Name	Description of Scale (The extent to which the teacher …….)	Sample Item		
		Student Actual	Teacher Actual	Student/Teacher Preferred
Leadership	… leads, organizes, gives orders, determines procedure and structures the classroom situation.	This teacher explains things clearly.	I explain things clearly.	This teacher would explain things clearly.
Helping/Friendly	… shows interest, behaves in a friendly or considerate manner and inspires confidence and trust.	This teacher is someone we can depend on.	I am someone students can depend on.	This teacher would be someone students can depend on.
Understanding	… listens with interest, empathises, shows confidence and understanding and is open with students.	This teacher is willing to explain things again.	I am willing to explain things again.	This teacher would be willing to explain things again.
Student Responsibility	… gives opportunity for independent work, gives freedom and responsibility to students.	We can influence this teacher.	Students can influence me.	Students could influence the teacher.
Uncertain	… behaves in an uncertain manner and keeps a low profile.	This teacher is not sure what to do when we fool around.	I am not sure what to do when students fool around.	This teacher would not be sure what to do when students fooled around.
Dissatisfied	… expresses dissatisfaction, looks unhappy, criticises and waits for silence.	This teacher puts us down.	I put students down.	This teacher would put students down.
Admonishing	… gets angry, expresses irritation and anger, forbids and punishes.	This teacher is impatient.	I am impatient.	This teacher would be impatient.
Strict	… checks, maintains silence and strictly enforces the rules.	This teacher's standards are very high.	My standards are very high.	This teacher's standards would be very high.

2.3.3 Reliability and Validity of the QTI in Previous Research

Factor analysis carried out on empirical data using class means as the unit of analysis confirmed that the two-factor structure of the QTI supported the eight scales and that both factors explain 80% of the variance on the scales of the Dutch version of the QTI (Brekelmans, 1989). Similar results were obtained for data obtained in the United States (Wubbels & Levy, 1991) and in Australia (Wubbels, Creton, Levy, & Hooymayers, 1993).

The reliability and validity of the QTI has been confirmed in Dutch, American, Australian and Singaporean studies (e.g. Brekelmans, Wubbels, & Creton, 1990; Fisher, Fraser, & Wubbels, 1993; Goh & Fraser, 1995; Wubbels & Levy, 1991).

Validation of the QTI has involved the use of Cronbach's (1951) alpha coefficient as an index of internal consistency (the extent to which items in the same scale measure the same dimension). Table 2.3 presents alpha coefficients for actual versions of the QTI in three countries. Coefficients are computed separately for the individual student and the class mean as the unit of analysis. According to Nunnally (1967), for instruments used in research, a sufficient scale internal consistency is 0.60. Alpha coefficients for the scales of the QTI ranged from 0.68 to 0.90 when the individual student was used as the unit of analysis and from 0.80 to 0.96 when class means were used as the unit of analysis. These figures all exceed Nunnally's benchmark of 0.6 indicating that each QTI scale displays satisfactory internal consistency.

A second feature of a quality classroom environment research instrument is that of discriminant validity whereby each scale measures a different dimension than that measured by any other scale of the instrument. In a quality instrument, each scale of the instrument should have a very small or negative correlation with all other scales in the instrument. However, a different technique must be used with the QTI because of the manner in which its scales are arranged. The eight scales of the QTI are represented by eight sectors arranged in circular fashion, so that as one type of teacher behaviour 'fades' into another, it is not unreasonable to expect two adjoining scales to have medium to large positive correlations. Inter-scale correlations, as

Table 2.3

Reliability (Cronbach Alpha Coefficients) for QTI Scales, Student Actual Form, Individual and Class Mean Level of Analysis for American (USA), Australian (A) and Dutch (D)Samples of Students

Scale	Individual Student Level			Class Mean Level		
	US	A	D	US	A	D
Leadership	0.80	0.83	0.83	0.94	0.94	0.94
Helping/ Friendly	0.88	0.85	0.90	0.95	0.95	0.95
Understanding	0.88	0.82	0.90	0.94	0.94	0.96
Student Responsibility	0.76	0.68	0.74	0.86	0.80	0.85
Uncertain	0.79	0.78	0.79	0.96	0.92	0.92
Dissatisfied	0.83	0.78	0.86	0.90	0.93	0.92
Admonishing	0.84	0.80	0.81	0.92	0.92	0.90
Strict	0.80	0.72	0.78	0.95	0.90	0.89

N = 1606 USA students in 66 classes N = 792 A students in 46 classes

N = 1105 D students in 66 classes Source: Wubbels & Levy (1993)

illustrated in Table 2.4, show that in general highest correlations are found between adjacent scales and the lowest correlations between scales opposite to each other. This indicates that the QTI has acceptable discriminant validity (Wubbels, Creton, Levy, & Hooymayers, 1993).

Table 2.4

Correlations between the Scales of the QTI using Students as the Unit of Analysis

Scale	DC	CD	CS	SC	SO	OS	OD	DO
Leadership (DC)	1.00	0.61	0.50	-0.12	-0.72	-0.48	-0.33	0.02
Helping/Friendly (CD)		1.00	0.86	0.38	-0.34	-0.68	-0.60	-0.42
Understanding (CS)			1.00	0.44	-0.23	-0.69	-0.63	-0.49
Student Responsibility (SC)				1.00	0.34	-0.24	-0.33	-0.48
Uncertain (SO)					1.00	0.44	0.29	-0.03
Dissatisfied (OS)						1.00	0.76	0.53
Admonishing (OD)							1.00	0.54
Strict (DO)								1.00

N = 2407 students

Source: Wubbels, Creton, & Hooymayers (1985)

A third important feature of a quality classroom research instrument is its capacity to measure that differences in student perceptions are more a result of class differences than student differences (Fraser, McRobbie, & Giddings, 1993). One-way analysis of variance (ANOVA), using class membership as the main effect, is commonly applied to determine an instrument's capacity to differentiate between classes. Table 2.5 presents such an analysis of data from Dutch and Australian samples. The eta^2 statistic, which represents the proportion of the variance in QTI scores accounted for by class membership, ranged from 0.36 to 0.59 for the Dutch sample and from 0.22 to 0.35 for the Australian sample. For both samples each scale of the QTI differentiated significantly (Dutch sample, $p<0.01$ and Australian sample, $p<0.001$) between student perceptions in different classrooms.

Table 2.5

Ability to Differentiate Between Classrooms for the QTI Scales for Dutch and Australian Student Samples

Scale	ANOVA Results (eta^2)	
	Dutch	Australian
Leadership (DC)	0.59*	0.33**
Helping/ Friendly (CD)	0.48*	0.35**
Understanding (CS)	0.43*	0.32**
Student Responsibility (SC)	0.36*	0.26**
Uncertain (SO)	0.59*	0.22**
Dissatisfied (OS)	0.39*	0.23**
Admonishing (OD)	0.39*	0.31**
Strict (DO)	0.45*	0.23**

* $p<0.01$ ** $p<0.001$

N = 1606 Dutch students N = 3994 Australian students

Source: Wubbels & Levy (1991), Fisher, Fraser, & Rickards (1997)

The data referred to in this section confirmed that the QTI is a reliable and valid questionnaire.

2.3.4 Previous Studies Involving the QTI

The QTI has been used in a variety of classroom settings in a range of contexts. These contexts include:

* the investigation of differences in perceptions of actual and preferred teacher interpersonal behaviour from the perspectives of both students and teachers
* the determination of associations between student perceptions of teacher interpersonal behaviour and new curricula, student achievement and attitude, and cultural factors.

A number of studies have focused on the use of the QTI and the professional development of teachers. Studies referred to in this section have been selected because of their relevance to the objectives of this particular study.

Creton, Hermans, and Wubbels (1990) reported on a study involving students in physics classes. Variations in students' appreciation of the subject and the lessons were shown to be characterized on the proximity dimension rather than on the influence dimension. That is, student responsibility, understanding, helping/friendly and leadership behaviours were found to be related positively to student attitudes while uncertain, dissatisfied, admonishing and strict behaviours were negatively related to attitudes. The aspects of teacher interpersonal behaviour identified by Creton et al as being associated with favourable student attitudes were very similar to those reported by Holloway (1994) as characteristics of teachers thought by students to be especially helpful and encouraging.

A study reported by Brekelmans, Wubbels, and Creton (1990) investigated grade 9 physics students perceptions of the interpersonal behaviour of their teachers. Data for the study were gathered by students completing the QTI in 65 classrooms, 21 using a new curriculum, 44 using the traditional curriculum. The main outcome reported was a rather strong relationship between teacher interpersonal behaviour and student outcomes. The relationship between teacher interpersonal behaviour and the affective outcome was reported as being stronger that the one between teacher interpersonal behaviour and the cognitive outcome. Leadership interpersonal

behaviour was reported as being most closely related to both high affective and high cognitive student outcomes.

Wubbels (1993) used the QTI with a sample of 66 grade 9 physics classes in the Dutch option of the Second International Science Study, where he investigated relations between interpersonal teacher behaviour and student achievement and attitude. Amongst his findings were that students' perceptions of interpersonal teacher behaviour appeared to account for much of the outcome differences between classes of similar ability (70% variability in achievement and 55% in attitude) and that differences in student outcomes varied much more due to different teacher interpersonal behaviours than different curricula or teachers' age or teaching experience. This study also revealed that students taught by teachers who had higher scores on the submissive side of the D-S axis than the 'average' teacher had better attitudes towards physics, and that students taught by teachers showing more DO, DC and CD sector behaviour had better achievement.

Another study (Brekelmans, Wubbels, and Levy, 1993), which also focused on students in physics classes, reported on an investigation of relationships between perceptions on the QTI scales and students' cognitive outcomes. The difference between the various types of teachers could be characterized on the basis that the more that teachers demonstrated strict, leadership and helping/friendly behaviour, the higher the cognitive outcomes. Conversely, student responsibility, uncertain and dissatisfied behaviour were negatively related to achievement. The results of this study suggest that student achievement is more strongly associated with variations in teacher behaviour on the influence dimension than on the proximity dimension.

A team of researchers in Australia completed the first use of the 48-item Australian version of the QTI in senior biology classes with a sample of 489 students in 28 biology classes (Fisher, Henderson, & Fraser, 1995). Although past studies have examined associations between student perceptions of the learning environment in science classes and student outcomes, this study was unique in that it examined student outcomes in three distinct areas – student attitude, achievement in a written examination and performance on practical tests. Generally, the dimensions of the QTI were found to be associated significantly with student attitude scores. In

particular, students' attitude scores were higher in classrooms in which students perceived greater leadership, helping/friendly and understanding in their teachers' interpersonal behaviours. Conversely, students' attitude scores were lower in classrooms in which students perceived greater uncertainty, dissatisfaction, admonishing and strictness in their teachers' interpersonal behaviour. It was concluded that if biology teachers want to promote favourable student attitudes in their class and laboratory work, they should ensure the presence of these interpersonal behaviours.

A case study approach was used by Fisher, Fraser, and Cresswell (1995). In this study six science teachers from the same school decided to embark on a professional development exercise together following their introduction to the QTI and realization of its potential. The teachers shared their results and discussed possible strategies they could implement to bring about a change in their own interpersonal relationships with their students. Since the QTI was able to provide the teachers with a picture of their ideal teacher, how they saw themselves and how students saw them, these pictures became the focus for the teachers' self-reflection and ensuing discussions.

In a later study, Fisher, Rickards, and Fraser (1996) described how teachers can use the results of the various forms of the QTI as a basis for modifying their behaviour when interacting with students. Sector profiles could be used when considering staff development activities as they provide individual science teachers with information about their actual and preferred classroom environments. The sector diagrams could also be used as a basis for discussion of teacher behaviours. The QTI can be used to monitor students' views of their classes, investigate the impact that different interpersonal behaviours have on student outcomes, and provide a basis for guiding systematic attempts to improve this aspect of their teaching. The QTI could also be used in assessing changes that result from the introduction of new curricula or teaching methods, and in checking whether the science teachers' interpersonal behaviour is seen differently by students of different gender, abilities or ethnic backgrounds.

Waldrip and Fisher (2003) used the QTI in an attempt to identify and describe exemplary science teachers. These teachers were identified according to the perceptions of their students on particular QTI scales and follow up interviews with students and principals. In relation to other teachers, those classified as exemplary scored appreciably higher on the Leadership, Helping/Friendly and Understanding scales and lower on the Uncertain, Dissatisfied and Admonishing scales. Students perceived that these exemplary teachers tried to engage them in the learning process, understood their needs as learners, were friendly, gave them responsibility but demonstrated a degree of strict behaviour that the students were comfortable with and which was conducive to learning.

Research conducted using the QTI has shown that teacher-student communication patterns are distinct and take recognizable forms (e.g., Wubbels, Brekelmans, & Hermans, 1987; Wubbels & Levy, 1991). Based un such research, a typology of interpersonal teaching styles was developed (Brekelmans, Wubbels, & Levy, 1993). Eight distinct interpersonal profiles were identified – Directive, Authoritative, Tolerant/Authoritative, Tolerant, Uncertain/Tolerant, Uncertain/Aggressive, Repressive and Drudging. These eight teacher types can be characterized by means of the two dimensions in the *Model for Interpersonal Teacher Behaviour* (Wubbels & Levy, 1993). They can also be described in terms of what can be observed in the classroom (Brekelmans, Levy, & Rodriguez, 1993). These eight profiles have been found to consistently appear in both Dutch and American samples of teachers (e.g., Wubbels & Brekelmans, 1998).

The eight interpersonal teacher types have been linked to student outcomes (Brekelmans, Wubbels, & Levy, 1993). Highest achievement was noted in classes of Repressive, Tolerant and Directive teachers while lowest achievement occurred in classes of Uncertain/Tolerant and Uncertain/Aggressive teachers. Highest levels of motivation were associated with Authoritative, Tolerant/Authoritative and Directive teachers while lowest levels were evident in classes of Drudging and Uncertain/Aggressive teachers. Tolerant/Authoritative teachers exhibited characteristics most closely associated with the ‘ideal’ teacher.

Rickards, den Brok, and Fisher (in press) reported on the first attempt to develop typologies of Australian science teachers based on teacher-student interpersonal behaviours. They determined that while all existing types of teacher were located in the Australian sample, the existing typology only partially applied. The findings of their study showed that more than 85% of the teachers in the sample could be classified as either Directive, Authoritative or Tolerant/Authoritative while Uncertain/Tolerant, Uncertain/Aggressive and Repressive teachers were hardly represented. The typology of the Australian sample consisted of seven types of teacher. As well as the Tolerant/Authoritative, Authoritative, Directive and Uncertain/Aggressive types previously classified (Brekelmans, et al., 1993), three new types were identified and labeled as Directive/Authoritative, Flexible and Cooperative/Supportive. While not in widespread use at the moment, the use of typologies provides immense potential for the professional development of teachers in relation to improving the teaching-learning process and maximizing student outcomes.

The results of these studies involving the use of the QTI indicate that interpersonal teacher behaviour is an important aspect of the learning environment and is strongly linked to student outcomes.

2.4 THE SCIENCE LABORATORY ENVIRONMENT INVENTORY (SLEI)

Laboratory work is seen as an integral part of most science courses and offers an environment different in many ways from that of the 'traditional' classroom setting. Hofstein & Lunetta (1982), whilst differentiating between laboratory activities and verbal learning, suggested that the role and effectiveness of the science laboratory were far from clear, but research studies in this field have concentrated on evaluating different kinds of laboratory activities rather than assessing laboratory environments.

The development of the Science Laboratory Environment Inventory (SLEI) has provided an avenue for studies of the laboratory learning environment.

2.4.1 Laboratory Work in Science

Shulman and Tamir (1972) used a review of the literature to propose five broad goals for laboratory teaching in science:

(a) To promote skills (e.g. investigative, manipulative, inquiry).

(b) To facilitate the understanding of concepts.

(c) To develop cognitive abilities (e.g. critical thinking, problem-solving, creativity).

(d) To promote an understanding of the nature of science, including scientific methods and the relationships between science and technology.

(e) To promote positive attitudes towards science (e.g. by encouraging curiosity, interest and collaborative work).

They noted, however, that these goals were similar to those given for science education in general. Goals more specifically related to science laboratory work were proposed by Lunetta, Hofstein, and Giddings (1981). These goals, expressed in terms of student outcomes, were grouped into one of three domains: cognitive (e.g. promoting intellectual development and the development of problem-solving skills); practical (e.g. promoting the development of manipulative, analytical and communication skills); affective (encouraging positive attitudes towards science and promoting confidence in one's ability to understand and affect one's environment).

Research into the perceptions of students and teachers regarding the value of laboratory work has not yielded consistent findings (Klainin, 1988), but the views of Kreitler and Kreitler (1974), that experimental work does not promote curiosity in students nor greatly facilitate the acquisition of knowledge and the development of concepts, is not borne out by research findings. Studies of associations between laboratory work and student outcomes have provided evidence that laboratory work promotes positive student attitudes to science (e.g. Johnson, Ryan, & Schroeder, 1974; Milson, 1979; Okebukola, 1985; Osborne, 1976; Raghubir, 1979), but the results of Fordham's (1980) study suggest that laboratory work in itself will not promote students' intrinsic motivation (curiosity) unless students are presented with some degree of challenge.

The findings related to the advantages of laboratory investigations have not been equivocal. Ausubel (1968) believed that laboratory work was inefficient and time-consuming and useful only for teaching the spirit of science. Research findings reviewed by Novak (1988) suggested that laboratory work did not contribute significantly to students' knowledge construction or understanding of concepts. Yager, Engen, and Snider (1969) also found that laboratory work did not significantly contribute to students' cognitive or affective outcomes, although the methodology of this study has been strongly criticized by Hofstein and Lunetta (1982).

2.4.2 Development of the SLEI

The SLEI (Fraser, McRobbie, & Giddings, 1993) was developed to assess student perceptions of the psychosocial environment of science laboratory classes at senior secondary or higher levels. Five criteria guided the development of the SLEI:

1. Dimensions considered to be unique in science laboratory classrooms were identified through extensive review of the literature.
2. A review of all scales contained in existing classroom environment instruments was undertaken to help with the identification of relevant dimensions.
3. Dimensions selected provided coverage of Moos (1974) three general categories of dimensions conceptualizing all human environments (Fraser & McRobbie, 1995).
4. Dimension and item salience to teachers and students was ensured through their feedback on draft versions of sets of items.
5. Economy of time with regard to answering and scoring the instrument was ensured by the inclusion of a relatively small number of reliable scales, each containing a small number of items.

Each of the 35 items in the SLEI is assigned to one of five scales: Student Cohesiveness, Open-endedness, Integration, Rule Clarity and Material Environment. The use of these scales provides coverage of the three dimensions identified by Moos (1974) for conceptualizing all human environments. Table 2.6 shows the

classification of each scale of the SLEI according to Moos' scheme and provides descriptive information for each scale.

Table 2.6

Descriptive Information for each Scale of the SLEI

Scale Name	Moos Category	Description
Student Cohesiveness	Relationship	Extent to which students know, help and are supportive of one another.
Open-endedness	Personal Development	Extent to which the laboratory activities emphasize an open-ended, divergent approach to experimentation.
Integration	Personal Development	Extent to which the laboratory activities are integrated with non-laboratory and theory activities.
Rule Clarity	System Maintenance and Change	Extent to which behaviour in the laboratory is guided by formal rules.
Material Environment	System Maintenance and Change	Extent to which the laboratory equipment and materials are adequate.

Students respond to each item of the SLEI on a five-point Likert-type scale with the alternative responses being *very often* (5), *often* (4), *sometimes* (3), *seldom* (2) and *never* (1). The scoring is reversed in approximately half the items. There are 'Actual' and 'Preferred' forms of the SLEI and when completing them, students indicate perceptions of their current and preferred environments. A *class* form (measuring a student's perceptions in relation to the class as a whole) and a *personal* form (measuring a student's perceptions of his/her role within the class) also exist. A copy of the Actual and Preferred personal versions of the 35-item SLEI used in this study can be found in Appendix B of this thesis.

2.4.3 Reliability and Validity of the SLEI in Previous Research

A series of factor analyses carried out on the SLEI confirmed the factorial validity of the internal structure of the instrument when used in secondary schools (Fraser, Giddings, & McRobbie, 1995). These analyses indicated that the total variance extracted by the five factors ranged from 41% for the preferred version with the individual student as the unit of analysis to 69% for the actual version with class means as the unit of analysis.

Fraser, McRobbie, and Giddings (1993) reported that field testing of the SLEI in six countries (Australia, USA, Canada, England, Israel and Nigeria) had confirmed this instrument's reliability and validity. The figures presented in Table 2.7 show that alpha reliability coefficients for each scale ranged from 0.70 to 0.83 when the individual student was used as the unit of analysis and were, as expected, even higher when class means were used. Mean interscale correlations were low enough (0.07 – 0.37 with the student as the unit of analysis) to confirm the discriminant validity of the SLEI, indicating that each scale measures distinct, although overlapping, aspects of the laboratory environment. The proportion of variance attributable to class membership (0.19 – 0.23) indicated that the SLEI is capable of discriminating significantly (p<0.001) between the perceptions of students in different classes.

Table 2.7

Internal Consistency (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation with Other Scales) and Ability to Differentiate Between Classrooms for the SLEI in Six Countries

Scale	Unit of Analysis	Alpha Reliability		Mean Correlation with other Scales		ANOVA Results (eta^2)
		Actual	Preferred	Actual	Preferred	Actual (p<0.001)
Student	Individual	0.77	0.72	0.34	0.39	0.21*
Cohesiveness	Class Mean	0.92	0.89	0.39	0.42	
Open-	Individual	0.70	0.60	0.07	0.13	0.19*
endedness	Class Mean	0.81	0.72	0.11	0.16	
Integration	Individual	0.83	0.81	0.37	0.39	0.23*
	Class Mean	0.95	0.92	0.41	0.32	
Rule Clarity	Individual	0.75	0.70	0.33	0.35	0.21*
	Class Mean	0.92	0.85	0.38	0.39	
Material	Individual	0.75	0.72	0.37	0.41	0.21*
Environment	Class Mean	0.88	0.89	0.42	0.45	

Source: Fraser, McRobbie, & Giddings (1993)

2.4.4 Previous Studies Involving the SLEI

The SLEI has been used in various contexts, including non-English speaking as well as English speaking countries. Contexts include:

* differences in perceptions of actual and preferred laboratory learning environments from the perspectives of both students and teachers
* associations between laboratory learning environments and students' attitudes towards the subject
* associations with cognitive and affective outcomes.

McRobbie and Fraser (1993) used the SLEI in the first investigation into associations between learning environments and student outcomes that was conducted specifically in science laboratory class settings. A sample of 1594 senior high school chemistry students responded to the SLEI. Student outcomes were gauged using two measures of inquiry skills and four attitude measures. The findings indicated that students' perceptions of the classroom psychosocial environment accounted for appreciable amounts of variance in student outcomes even when student ability was controlled. Of the five scales of the SLEI, Integration showed the strongest positive association with both students' cognitive and attitudinal outcomes, whilst the few negative associations included those between Rule Clarity and students' inquiry skills.

The SLEI was used in a study of outcome-environment relationships in Papua New Guinea (Waldrip and Giddings, 1993). This study involved 1707 students' scores on an external science examination, 987 students' scores on a laboratory performance test and 1590 students' responses to a scale measuring students' attitudes to science. Significant relationships emerged for each of the three outcomes, but associations were stronger for the attitudinal outcome than for either achievement or practical performance in the laboratory. In particular, integration (the link between theory and laboratory classes) was the strongest and most consistent correlate of student outcomes. In a somewhat similar study in Nigeria (Fraser, Okebukola, & Jegede, 1992) involving 218 senior high school students and 170 university students, all dimensions of the SLEI except open-endedness were found to be associated positively with student attitudes towards science.

Wong and Fraser (1995) used the personal form of the SLEI with a sample of high school chemistry students in Singapore. This study provided further cross-cultural validation of the actual and preferred forms of the SLEI with either the individual student or the class mean used as the unit of analysis. All scales of the SLEI except Open-endedness, and especially Integration and Rule Clarity, were found to be positively related to students' attitudinal outcomes.

Lee and Fraser (2001) used the SLEI to investigate Korean high school students' perceptions of their laboratory classrooms. The study involved 439 high school students from three different streams – 145 from the humanities stream, 195 from the science-oriented stream and 99 from the science-independent stream. Using the average item mean for different SLEI scales it was found that students perceive a relatively high level of Student Cohesiveness in their laboratory lessons and that laboratory classes are highly coordinated with theory classes as illustrated by the high means reported for the Integration scale. As implied by the results for the Open-endedness scale, laboratory lessons are normally carried out using 'ready-made' procedures and results. The mean for the Rule Clarity scale indicates that rules in laboratory classes are relatively clear. Results for the Material Environment scale showed that students perceived laboratory equipment and materials to be inadequate. These results from survey data were further explored with interview and observation data.

The differences between the perceptions of students in the three streams were also investigated in this study. The Integration scale was perceived relatively similarly across streams. Students from the humanities stream and the science-oriented scheme perceived their classes similarly, but their perceptions were significantly different from those of students in the science-independent stream. Science-independent stream students perceived more open-ended laboratory lessons, with less clear rules and better materials, than did students in the other two streams. Findings from interviews and observations regarding happenings in laboratory classes reflected the findings from the SLEI.

A number of classroom environment studies have incorporated the use of both the QTI and SLEI, or modifications of them. Because both these instruments have been

used in the current study, it is deemed appropriate to report on some of the earlier studies.

Henderson, Fisher and Fraser (2000) reported on a study involving 489 students from 28 senior biology classes in eight schools in Tasmania, Australia. This study is distinctive in that it included student perceptions of interpersonal teacher behaviour and student perceptions of the laboratory environment in the one study, and because it investigated outcome-environment associations with three categories of student outcomes (attitudes, achievement and practical performance).

Students completed the actual and preferred forms of the 48-item Australian version of the QTI to provide information about their perceptions of teacher interpersonal behaviour. They also responded to the actual and preferred forms of the SLEI, allowing comparisons to be made between their perceived actual and preferred laboratory environments. Student attitudes were assessed with an eight-item Attitude to Science Laboratory Work scale and a seven-item Attitude to this Class scale, both of which were adapted from the *Test of Science-Related Attitude* (TOSRA) (Fraser, 1981b).

The findings of the study replicated those of previous studies in identifying substantial differences between students' perceptions of their actual and preferred learning environments. The study indicated that many aspects of teacher interpersonal behaviour and the laboratory learning environment are associated with students' attitudinal outcomes. In particular, favourable student attitudes were found to be associated with a students' perceptions of the teachers' strong leadership, a greater degree of integration of practical and theory work, and more rule clarity. Associations between students' perceptions of the learning environment and achievement outcomes identified in this study suggest that if the teacher displays strong leadership characteristics, provides increased student responsibility and freedom, and more effectively integrates the practical and theory components of the biology course students are more likely to achieve at a higher level, whereas a greater degree of strict behaviour exhibited by the teacher, additional emphasis on rule clarity and a more open-ended approach to practical work are negatively associated with student achievement.

The results of this study also indicate that teacher interpersonal behaviour, as measured by the QTI, and the laboratory learning environment, as measured by the SLEI, are complementary rather than overlapping aspects of the learning environment in relation to their associations with student outcomes. Therefore, the use of both instruments in the same study provides a more complete picture of those aspects of the learning environment likely to promote student attitude and achievement.

In another study Quek, Wong, and Fraser (2001) investigated the impact of the chemistry laboratory environment and teacher-student interaction on student attitudes towards chemistry for a sample of secondary school students in Singapore. The data were obtained using the 35-item *Chemistry Laboratory Environment Inventory* (CLEI) which was an adaptation of the SLEI, the 48-item Australian version of the QTI and the 30-item *Questionnaire on Chemistry-Related Attitudes* (QOCRA).

The sample consisted of 497 final-year secondary school (Year 10 equivalent) chemistry students from 18 classes in three independent single-sex schools in Singapore. Nine of the classes consisted of gifted students in a Gifted Education Program (GEP) while the other 9 classes consisted of non-gifted students in an 'Express' stream.

A comparison of gifted and non-gifted students' mean scores on the five scales of the actual and preferred forms of the CLEI showed that the gifted students perceived the actual and preferred chemistry laboratory environment more favourably than the non-gifted group. The most significant differences in favour of the gifted students were obtained for the Student Cohesiveness, Integration and Material Environment scales.

A comparison of boys' and girls' perceptions for the CLEI showed that boys viewed their actual chemistry laboratory environment significantly less favourably than girls in the areas of rule clarity and material environment, while girls felt that there was a higher level of student cohesiveness than did boys. Gifted boys perceived the laboratory to be much less well equipped than did girls.

It was also found that student cohesiveness and open-endedness were significantly correlated with Adoption of Scientific Attitudes in Chemistry; student cohesiveness, open-endedness, rule clarity and material environment were associated significantly with Attitude to Scientific Inquiry in Chemistry and that integration was significantly correlated with Enjoyment of Chemistry Lessons. All of these correlations were positive.

When considering teacher interpersonal behaviours, as measured by the QTI, gifted students perceived their chemistry teachers as demonstrating a higher degree of leadership, helping/friendly and understanding behaviours than did the non-gifted students.

Significant positive correlations existed between the Enjoyment of Chemistry attitude scale and the QTI scales of Leadership, Understanding and Helping/Friendly. Significant negative correlations were found between the same attitude scale and the Uncertain, Dissatisfied and Strict QTI scales.

Kijkosol and Fisher (2004) conducted a study in Thailand using both the QTI and SLEI to investigate associations between students' perceptions of their laboratory learning environments, teacher-student interactional and student attitudes to their biology classes. Positive associations were found between aspects of the learning environment and student attitudes to their biology classes. In particular, it was found that students prefer teachers who show strong leadership, are more helping/friendly and understanding, and who give them more responsibility and freedom. They also prefer their teachers to display less uncertain, admonishing, dissatisfied and strict behaviours. Students prefer a laboratory environment where there are higher levels of open-endedness, integration and rule clarity as well as a better material environment. Positive attitudes to biology classes were evident in classes where the students perceived greater leadership and less admonishing behaviour from their teachers. In terms of the laboratory environment, positive associations existed between students' attitudes towards biology and high levels of open-endedness and rule clarity as well as a better material environment.

2.5 ATTITUDINAL OUTCOMES

Difficulties have been encountered in providing a clear and generally-accepted meaning of the term "attitude", to the extent that attitudinal outcomes measured in different studies are not necessarily compatible. For the purposes of this study, the seven-item Attitude to This Class scale, based on the Test of Science-Related Attitude (TOSRA) (Fraser, 1981b) was used. A copy of this scale can be found in Appendix C.

2.6 SUMMARY

This study is significant in that it responds to an identified need in a secondary school to improve science students' results and attitudes. The theoretical basis of the study was influenced by the findings of previous studies utilising classroom environment instruments. The focus of this chapter has been the review of some of these previous studies.

The study of classroom learning environments began in earnest in the 1970's with the development of the CES and the LEI. Since then many instruments have been developed for the study of a variety of aspects of the classroom environment. Amongst these have been the QTI which focuses specifically on the teacher's interpersonal behaviour in the classroom, and the SLEI which investigates the science laboratory learning environment.

The decision to examine associations between teacher-student interpersonal behaviour, aspects of the science laboratory environment and students' cognitive and attitudinal outcomes was prompted by previous research findings that suggest there is a strong association between these variables.

Given that this study was responding to a particular need of a school, it was important to review previous studies that focused on teachers' practical attempts to improve their classroom environments. The use of different forms, for example actual and preferred, of classroom environment instruments has enabled classes to be

profiled from more than one perspective so that intervention strategies can be implemented to improve the learning environment and hence, student outcomes.

A mixed method design, combining quantitative and qualitative methods, was chosen to minimise the inherent weaknesses of each method as recommended by Tobin and Fraser (1998). Qualitative data can be used to complement, explain and amplify information gained through quantitative methods.

While this chapter reviewed related research for this study, the next chapter describes the research methods employed in this study. It is here that theory and practice are combined in a five-phase process designed to bring about positive changes to targeted aspects of teacher-student interpersonal behaviours and the science laboratory learning environment.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Chapter 2 presented a review of the literature and indicated the theoretical basis upon which previous studies into learning environment research have been developed. A particular focus was the development, validation and previous use of the two learning environment instruments used in this study – the QTI and SLEI.

This chapter outlines the methodology used in this study to collect and analyse data in relation to the objectives outlined in Chapter 1 and restated below. This study took the form of a case study focusing on secondary science classrooms in a North Queensland state secondary school. Both quantitative and qualitative methods were used in the study.

3.2 OBJECTIVES AND RESEARCH QUESTIONS

3.2.1 Objectives of the Study

1. To investigate students' perceptions of their actual and preferred science classroom and laboratory learning environments through the use of two instruments – the QTI and SLEI.
2. To identify specific teacher interpersonal behaviours, as perceived by students, that differ significantly from preferred behaviours.
3. To identify aspects of their science laboratory learning environment that students perceive to be significantly different from the preferred situation.
4. To describe and evaluate an intervention process developed and implemented to reduce the disparity between students' actual and preferred perceptions of targeted teacher interpersonal behaviours from those identified in Objective 2 and targeted aspects of the science laboratory learning environment from

those identified in Objective 3 and hence improve students' cognitive outcomes in science.

5. To determine associations between students' cognitive outcomes, attitudinal outcomes and perceptions of their classroom and laboratory learning environments.

3.2.2 Research Questions

1. Are the QTI and SLEI valid and reliable instruments for use in Queensland schools?
2. How do junior science students' perceptions of the actual teacher-student interpersonal behaviours being exhibited in their classrooms differ from those that they would prefer to be occurring:
   (a) prior to the intervention process
   (b) after the intervention process?
3. How do junior science students' perceptions of their actual laboratory learning environments differ from their preferred ones:
   (a) prior to the intervention process
   (b) after the intervention process?
4. What associations exist between junior science students' outcomes (attitudinal and cognitive) and their perceptions of teacher-student interpersonal behaviours?
5. What associations exist between junior science students' outcomes (attitudinal and cognitive) and their perceptions of laboratory learning environments?

3.3 COMBINING QUALITATIVE AND QUANTITATIVE RESEARCH

Many researchers concur on the advantages of combining qualitative and quantitative methods (Aldridge & Fraser, 2000; Creemers & Reezigt, 1999; Fraser, 1999a; Roth, 1998; Tobin & Fraser, 1998). The use of classroom environment instruments offer an economical way to gather information from a large sample, but they are unable to provide the explanations behind the responses. Interviews can provide some of these missing details, but they are time consuming (Morgan, 1997). Observations put the

researcher into the actual learning environment, but they are clouded by the personal perceptions of the observer (Denzin, 1994). Also, a more complete picture of the learning environment can be provided (Aldridge & Fraser, 2000; Aldridge, Fraser, & Huang, 1999; Creemers & Reezigt, 1999; Fraser, 1999a; Roth, 1998). Qualitative data, collected by looking and asking, enable researchers to document the conduct of everyday events and to identify the meanings of these events (Erickson, 1998). Insights gained by one method are followed up by using other methods.

The predominant data collection method utilized in this study was the use of classroom environment questionnaires but informal interviews and observations were also used to provide qualitative information. The use of classroom environment questionnaires provided information about student's perceptions of their actual and preferred student-teacher interactions and science laboratory environments. The resulting quantitative data allowed standardized, objective comparisons to be made and descriptions of key aspects of these interactions and environments to be formulated. Qualitative information, gathered via informal questioning and observations, allowed the quantitative findings to be contextualized, providing situation specific insights into student perceptions.

3.4 ASSOCIATIONS BETWEEN STUDENTS' COGNITIVE AND AFFECTIVE LEARNING OUTCOMES AND CLASSROOM ENVIRONMENT

One of the objectives of the study was to determine associations between students' perceptions of their classroom and laboratory environments and student outcomes.

The strongest tradition in past classroom environment research has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classrooms (Fraser, 1998a; Haertel, Walberg, & Haertel, 1981). Numerous research programs have shown that student perceptions account for appreciable amounts of variance in learning outcomes, often beyond that attributable to background student characteristics. To permit investigation of associations between student perceptions of the science laboratory learning environment and teacher interpersonal behaviours and student attitudes to science, a modified version of the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981b) was administered. Another aspect of the study

involved investigating the associations between students' perceptions of the science laboratory learning environment and teacher interpersonal behaviours and students' cognitive achievement in science. Cognitive achievement data were obtained in the form of the Level of Achievement the student was awarded for science for the semester in which the reassessment phase of the study occurred. Levels of achievement are determined by the class teacher, in consultation with the head of the science department, and are based on unit tests, research assignments and practical assignments completed by students throughout the semester. Students completing the same units of work undertake common assessment tasks which have been developed by the teachers and checked by the head of the science department. In the current study, associations between students' cognitive and attitudinal outcomes and aspects of their science classroom environments were investigated using simple correlations, multiple correlations and standardized regression coefficients at the student level.

3.5 PHASES OF THE STUDY

As indicated in Chapter 1, the approach selected was one which had been used successfully in studies cited by Fraser (1994), Fisher and Fraser (1990), Fraser (1989), Fraser and Fisher (1986), and Fraser and Deer (1983). It involved five basic steps as outlined below. This approach is particularly suited to this study which is being conducted in the school where the researcher is head of the science department. It addresses not only the collection of data but the use of the data in an attempt to bring about a desired change – improving students science results. This chapter will be structured around these steps.

1. ASSESSMENT – Actual and Preferred Forms of the QTI and SLEI were administered to students.
2. FEEDBACK – responses were analysed and presented as profiles illustrating means of actual and preferred scores. Aspects of the classroom environment (teacher-student interpersonal behaviours and laboratory practices) that need to be changed in order to reduce major differences between the actual and preferred environment were identified.

3. REFLECTION AND DISCUSSION – the junior science teaching team reflected on and discussed the findings, thus clarifying the implications of the responses. Decisions were then made on which aspects of the classroom environment were going to be targeted for change.
4. INTERVENTION – each participating teacher developed and implemented a classroom environment improvement plan, over a period of time, aimed at improving the specific aspects of the classroom environment that were targeted for change.
5. REASSESSMENT – the Actual Forms of the QTI and SLEI were administered again and responses analysed to determine whether or not there had been any perceived changes in the classroom environments. Junior science results were compared (starting prior to the beginning of the study and going through to the reassessment stage) to determine whether or not any improvement was obvious. Students also responded to a seven-item Attitude to This Class questionnaire.

Ethical clearance to conduct the study was granted by the relevant Queensland education authority as well as Curtin University of Technology. Steps 1, 2 and 3 were carried out in 1996. A sample of 256 Year 8, 9 and 10 students from 12 classes responded to Actual and Preferred Forms of the QTI and SLEI. Step 4 took place over an extended period of time from 1997 to 2000. Implementation of the new science syllabus does not have to be completed until 2003. Step 5 took place in late 2000. This allowed time for further intervention prior to complete syllabus implementation if reassessment indicates that this is required.

3.6 INVOLVING THE TEACHING TEAM

The involvement of the science teachers in the school where the study was conducted was of paramount importance. Because of the approach taken, the teachers needed to be heavily involved in the reflection and discussion and intervention phases of the study. This required a commitment on their part to be willing to make some planned changes to particular aspects of their teaching.

Because the researcher had worked closely with the other teachers for at least two years, she knew they were concerned with the poor science results that many of their students were achieving and would be open to suggestions as to how to improve these results. In light of this, she put a proposal to the teachers. This proposal had two components. The first involved the provision of some background reading material highlighting the field of classroom environment research with particular emphasis on the use of the QTI and SLEI and the use of classroom environment research in attempts to improve aspects of the learning environment and student outcomes. The second component outlined the format of the proposed study with particular emphasis on the role of the teacher and the objectives of the study.

At an initial meeting of the relevant teachers the researcher presented the proposal. She explained how the intended study would be carried out, linking the theoretical and practical aspects of classroom environment research. The teachers had the opportunity to ask questions before taking their copy of the proposal away to further consider it and discuss it with their colleagues. During the following week the researcher met individually with each teacher to answer any further questions and gauge their interest in participating in the study. All teachers agreed to participate in the study.

The researcher kept field notes of group and individual discussions that she had with the relevant teachers. These notes are a source of qualitative data relating to the teachers' perceptions of the five-step process used in an attempt to change certain aspects of their classroom environment. These data are reported and discussed in Chapter 6.

3.7 SAMPLE SELECTION AND DESCRIPTION

The population selected for this study was Year 8, 9 and 10 students from a State High School in rural North Queensland. Due to the nature of the study, initial and final data were collected several years apart. The sample from which the initial data were collected comprised 256 students from 12 science classes taught by 4 teachers. These students responded to both Actual and Preferred Forms of the QTI and SLEI. The sample from which the follow up data were collected comprised 250 students

from 13 science classes taught by 5 teachers. These students responded to Actual Forms of the QTI and SLEI as well as an Attitude to This Class questionnaire.

The next five sections of this chapter outline the key features of each of the five phases of the study in relation to the methods used to collect, present and analyse data.

3.8 ASSESSMENT PHASE

3.8.1 Sample

The sample selected for this component of the study was Year 8, 9 and 10 students from a North Queensland state secondary school, all of whom were enrolled in science. Given that one aspect of the aim of the study was to improve student's cognitive outcomes in science it was considered appropriate to involve all students currently studying science.

The original sample of 256 students was reduced to 208 for reasons discussed in Section 3.8.3. These students came from 12 science classes, taught by four different teachers. A letter was sent to parents of all students who were to participate in the study. This letter outlined the purpose and format of the study, gave assurances of confidentiality and allowed parents to decide whether or not they would allow their son or daughter to respond to the questionnaires used in this part of the study. Permission was not declined by any parents.

3.8.2 Data Collection

The 48-item Australian version of the QTI was used to gauge students' perceptions of teacher-student interactions and the SLEI was used to gauge students' perceptions of the laboratory environment in their science classes. Students were asked to complete Actual and Preferred Forms of each questionnaire. This occurred in May 1996. A science teacher who was on leave at the time took on the role of research assistant and administered the questionnaires to all classes. In consultation with the researcher, the following procedure was decided upon and implemented.

Week 1 - Research assistant visited each science class, explained the purpose of the study, outlined what the students would be asked to do and distributed the letter for parents explaining what needed to happen with them.
Week 2 – Research assistant administered the Actual Form of the QTI and SLEI to all science classes.
Week 3 – Research assistant administered the Preferred Form of the QTI and SLEI to all science classes.

The use of a research assistant ensured that all students received the same background information during Week 1 of the process and the same instructions during Weeks 2 and 3 when they were responding to questionnaires.

To allow the researcher to obtain qualitative information from specific students by referring to their responses to the questionnaires, it was necessary to be able to identify the student who completed a particular questionnaire. Using computer generated class lists, the researcher assigned each student a code which allowed them, their class and their teacher to be identified. Four sets of questionnaires, with student codes pre-entered, were compiled for each class (QTI Actual, QTI Preferred, SLEI Actual, SLEI Preferred). Accompanying each set was a class list containing each student's name and ID code. This was the only document which allowed students to be identified by name and it was always returned to the researcher with the completed questionnaires. When the research assistant was administering the questionnaires she simply needed to call out a student's name and give them the questionnaire that was labeled with their ID code. The names of students at no time appeared on questionnaires.

In her role as head of the science department in the school where the study was conducted, the researcher spent considerable time in science classrooms – observing student activities, interacting with students and assisting teachers. She also met regularly with science teachers, both individually and as a group. It was as part of these normal routines that qualitative data were collected, rather than setting up a more formal interview and observation process. Field notes of relevance to the study were kept by the researcher as a record of observations made by her, comments made

by students and teachers as well as responses to specific questions asked of students and teachers. Not all students who responded to the questionnaires were asked verbal questions. Those who were questioned were not specifically targeted but in some cases students self-selected by approaching the researcher and volunteering information after hearing conversations she had with other students. These field notes are the basis of qualitative data reported and discussed in Chapter 5. Details of specific questions that were asked at different stages of the study are also provided in Chapter 5.

3.8.3 Analysis of Quantitative Data

(a) Collating Student Responses

A spreadsheet using Microsoft Excel was designed to record all the necessary data. The code for each student was entered as well as their year level, gender, teacher, cognitive result and response to each item from the Actual and Preferred Forms of the QTI and SLEI. For those SLEI items requiring reverse scoring, this was done. Response formats for both questionnaires utilized a five-point Likert-type scale. For the QTI, the responses ranged from 0 (Never) to 4 (Always) while for the SLEI they were 1 (Almost Never), 2 (Seldom), 3 (Sometimes), 4 (Often) and 5 (Very Often).

Where there were only a small number of responses missing or invalid for any one student, they were scored using the mid-range score (2 for the QTI and 3 for the SLEI). In cases where there were more than two missing or invalid values for any one scale of a questionnaire for a single student, the student was removed from the sample. Any students who were absent when either the Actual or Preferred Forms of the questionnaires were administered were removed from the sample. This resulted in a final sample size of 208.

(b) Validation of Classroom Environment Instruments

The SPSS statistical package was used to analyse students' responses to provide evidence for the QTI and SLEI regarding scale internal consistency reliability and ability to differentiate between the perceptions of students in different classrooms. The Cronbach alpha coefficient was computed for each scale of the QTI and SLEI as an estimate of the internal consistency reliability. For the SLEI, the discriminant

validity of each scale was determined by calculating the mean correlation of each scale with other scales. All of these analyses were performed at the individual student level. An AVOVA, with class membership as the independent variable, was used to determine the ability of each QTI and SLEI scale to differentiate between classes.

(c) Descriptive Analyses

To describe the classroom environments that were the focus of the study, descriptive analyses based on student responses to the QTI and SLEI were used. The item mean, or scale mean divided by the number of items in the scale, was used as the basis for comparison between different scales of each instrument. These means were then used to produce graphical representations of students' average perceptions of their actual and preferred classroom environment for the whole sample as well as for subgroups of the whole sample. The subgroups used were individual teacher, year level, gender and result.

(d) Statistical Significance

Kerlinger (1979) stated that a statistically significant result is one that departs sufficiently from chance expectation. The 0.05 level means that an obtained result could occur by chance only five times in 100 trials. The 0.05 level was first chosen by Fisher (1950) and has persisted with researchers, especially those studying learning environments, because it is considered a reasonably good indicator. It is neither too high nor too low for most social scientific research. In some cases, statistical significance is also reported at other levels such as 0.01 or 0.001.

(e) The t-test

A statistic 't' is calculated from experimental results, such as the difference between two means. The calculated statistic is then checked (in this study using computer-based techniques) against a table of t-values. The tabled values are distribution values i.e. values expected by chance for various numbers of cases in experimental groups (N's). If the calculated t is equal to or greater than the corresponding t-table entry, for example, at the 0.05 level of significance, the result is considered statistically significant (Kerlinger, 1979).

3.8.4 Analysis of Qualitative Data

Field notes recording classroom observations, details of conversations with students, and researcher perceptions were carefully examined to determine whether or not they supported assertions based on quantitative analysis of the questionnaires.

3.9 FEEDBACK PHASE

In keeping with tradition, profiles in the form of line graphs were used to present item mean scores for the scales of the classroom environment instruments to enable easy comparison between scales and between the Actual and Preferred Forms of each instrument for the whole group as well as certain subgroups. Each participating teacher was provided with a set of profiles for both the QTI and SLEI comparing item means from student responses to questions making up each scale of the Actual and Preferred Forms of each instrument. Profiles were created for each of the following student groups:

* the whole sample
* male and female
* year 8, 9 and 10
* result in the form of Level of Achievement (VHA, HA, SA, LA, VLA)
* students taught by each of the four participating teachers.

Each profile was annotated with an explanation of the information it provided.

3.10 REFLECTION AND DISCUSSION PHASE

Armed with copies of the Actual and Preferred Forms of the QTI and SLEI, background information relating to each scale of the two instruments, the profiles described in Section 3.9 and a summary of the data analysis carried out using data collected in the assessment phase of the study, the participating teachers (which included the researcher) familiarized themselves with the available information.

The outcome of this phase of the study was a decision on which aspects of the classroom environment were to be targeted for change in order to align the actual environment more closely with that preferred by students.

3.11 INTERVENTION PHASE

Having decided which aspects of the classroom environment to target, each teacher developed a classroom environment improvement plan. Even though each teacher developed and implemented their own plan, they worked collaboratively with each other in doing this.

To assist teachers formulate their classroom environment improvement plan, each teacher was asked to focus on the aspects of the classroom environment targeted for change and then challenged to suggest why, for these aspects, there might be significant differences between the actual and preferred learning environment in their science classrooms, as identified by their students. Having done that, they were then asked to identify changes they felt needed to be made to reduce these differences. This informed the strategies the teacher was going to use in an attempt to bring about the desired changes.

3.12 REASSESSMENT PHASE

The effectiveness of the planned intervention process to reduce the differences between student perceptions of targeted aspects of their actual and preferred classroom environments was evaluated by readministering the Actual Forms of the QTI and SLEI and analyzing the data. Many of the procedures followed in this phase of the study replicated those already addressed in Section 3.8. Only additional information pertinent to the reassessment phase of the study will be included in this section of the chapter.

3.12.1 Sample

The sample selected for this component of the study was Year 8, 9 and 10 students from the same North Queensland state secondary school as the sample for the

assessment phase of the study. The original sample of 250 students was reduced to 218. These students came from 13 science classes, taught by five different teachers.

3.12.2 Data Collection

Once again, the 48-item Australian Form of the QTI was used to gauge students' perceptions of teacher-student interactions and the SLEI was used to gauge students' perceptions of their science laboratory environment. Students were asked to complete Actual Form of each questionnaire. Students also responded to the seven-item Attitude to This Class questionnaire. This occurred in October 2000.

The researcher administered the data collection process. Due to the time frame over which the study was conducted, the students responding to the questionnaires in this phase of the study were not the same students who had responded to the questionnaires in the initial phase of the study. Because of this, a letter explaining the purpose and format of the data collection process was sent to parents of all students who were to participate. Once again, permission was not declined by any parents. When distributing this letter to students, the researcher explained what students would be required to do in terms of responding to the questionnaires. In the following week, the researcher conducted the quantitative data collection on a class by class basis.

3.12.3 Analysis of Quantitative Data

(a) Collating Student Responses

As in the assessment phase of the study, data were recorded in a Microsoft Excel spreadsheet. The code for each student was entered as well as their year level, gender, teacher, cognitive result and response to each item from the Actual Forms of the QTI, SLEI and Attitude to This Class questionnaire. For those SLEI items requiring reverse scoring, this was done. The response format for the Attitude questionnaire utilized a five-point Likert-type scale where possible responses were 1 (Strongly Disagree), 2 (Disagree), 3 (Not Sure), 4 (Agree) and 5 (Strongly Agree).

(b) Validation of the Attitude to this Class Instrument

The SPSS statistical package was used to analyse students' responses to provide evidence for the Attitude to This Class questionnaire regarding scale internal consistency reliability. The Cronbach alpha coefficient was computed for the single scale of the Attitude to This Class questionnaire as an estimate of the internal consistency reliability. This analysis was performed at the individual student level.

(c) Simple Correlational Analysis

The associations between the scales of the two measuring instruments used in the study and the student cognitive and attitudinal outcomes were initially analysed using simple correlational analysis. The appropriate correlation coefficients were obtained using the scores of the individual student as the unit of analysis.

(d) Multiple Regression Analysis

Since there is more than one independent variable or scale in both the QTI and SLEI, multiple regression analysis was used to further explore the associations between student outcomes and learning environments. Multiple regression analysis enables weights (regression coefficients) to be calculated for each independent variable's contribution to the finding of a dependent variable. A low coefficient means that the independent variable to which the coefficient is attached is given less weight in the regression equation for calculating the value of a dependent variable. A high regression coefficient has the opposite meaning. In this study, standardized regression weights, beta weights (β), were used so that comparisons could be made between the effects of the various scales of the measuring instruments and student outcomes.

(e) Multiple Correlation

In this study, the calculation of the coefficient of multiple correlation was used as part of the investigation into the associations between the environmental measuring instruments and student outcomes. The coefficient of multiple correlation, R, expresses the magnitude of the relation between, on the one hand, the best possible combination of all the independent variables and, on the other hand, the dependent variable (Kerlinger, 1979). For example, if a regression equation is used to predict the student's cognitive results based on the regression coefficients for each of the

independent scales on the SLEI and the resultant set of data is then correlated with the actual student results, the correlation coefficient found is R. Another useful indicator is R^2 which expresses the amount of variance of the dependent variable, accounted for by the regression combination of all the independent variables (Kerlinger, 1979). It is an index of the maximum amount of variance of for example, cognitive outcomes, accounted for by all the scales of the SLEI.

3.12.4 Sharing the Findings

On completion of the analysis of data collected during the reassessment phase of the study, participating teachers need to be provided with feedback regarding the outcomes of the study. In the context of the five-step process around which the study was structured, this is actually a return to the feedback phase of the process. As seen in Figure 3.1, the process can in fact be considered to be cyclic.

Feedback occurred in a similar way to that previously described in Section 3.9. Additional information reported on associations between aspects of the classroom environment and students' cognitive and attitudinal outcomes. Also, information on student results and senior science class sizes was provided and commented on for the period of time between 1994 and 2002.

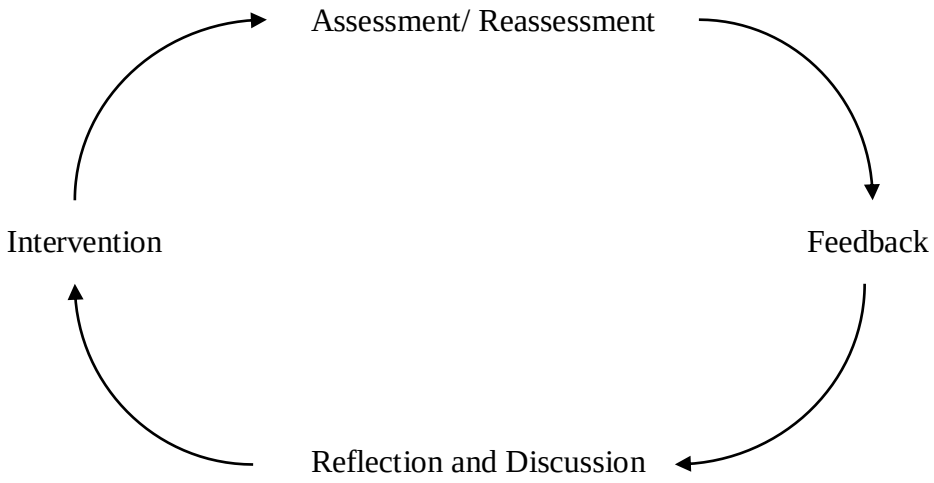

Figure 3.1. Cyclic process used to change aspects of classroom environments.

3.13 SUMMARY

This chapter detailed the objectives of the study and associated research questions as well as describing the quantitative and qualitative research methods used in this study. A particular focus was a description of the methodology used during each phase of the five-step process around which the study was structured. It also outlined the range of statistical techniques used both to determine validity and reliability of the relevant classroom environment instruments and to analyse the quantitative data.

The next three chapters outline the results obtained – Chapters 4 and 5 focusing on the first four stages of the study and Chapter 6 on the reassessment stage of the study. Since the study involved the use of two classroom environment instruments, the QTI and SLEI, their validity and reliability is addressed first.

CHAPTER 4

LEARNING ENVIRONMENT IMPROVEMENT PROCESS

4.1 INTRODUCTION

The next three chapters report on the analysis and findings of the quantitative and qualitative data collected in this study, and the subsequent practical applications implemented in a school setting. The structure of this chapter, as well as the next, is based on the first four steps in the learning environment improvement process around which this study has been developed. In general, Chapter 4 deals with quantitative data while Chapter 5 deals with qualitative data collected during the first four steps of this process. The final step of this process, the reassessment phase, is the focus of Chapter 6 where both quantitative and qualitative data are reported and analysed. This process was outlined in Section 3.3 of the previous chapter.

The first section focuses on the assessment phase of the study where students responded to the classroom environment instruments selected for use. The quantitative data collected from student responses to the Actual and Preferred Forms of the QTI and SLEI are used to confirm the reliability and validity of both instruments. The feedback phase forms the basis of the second section. Quantitative data are analysed to indicate what students' perceptions are of teacher-student interpersonal behaviours as well as the science laboratory environment. Differences between students' actual and preferred perceptions of aspects of their classroom environments are also identified. The third section highlights the reflection and discussion phase. Specific aspects of the classroom environment are targeted for change in order to reduce the differences between students' perceptions of their actual and preferred classroom environments. In the fourth section, details of the intervention phase are reported. Classroom environment improvement plans are developed and implemented by teachers in an attempt to better align targeted aspects of teacher-student interpersonal behaviours and the laboratory learning environment. A brief summary completes the chapter.

4.2 ASSESSMENT PHASE

A fundamental component of this study was to compare students' perceptions of certain aspects of their actual classroom environments with their preferred classroom environments. In the assessment phase of the study the data required to do this were collected as students responded to the Actual and Preferred Forms of the QTI and SLEI.

Details relating to the administration of these two instruments were provided in Section 3.5 of the previous chapter. This section reports on the reliability and validity of the QTI and SLEI for this study.

Students' responses to the Actual and Preferred Forms of the QTI were used to compare science students' perceptions of their teacher's interpersonal behaviour with the behaviour of the students' preferred teacher. To compare students' perceptions of their science laboratory learning environment with the laboratory environment they prefer, students' responses to the Actual and Preferred Forms of the SLEI were used.

4.2.1 Reliability and Validity of the QTI

A quality multi-scale classroom environment research instrument is one in which each scale has a high internal consistency (high Cronbach alpha coefficients), each scale measures a dimension of the classroom environment not measured by the other scales (low scale correlations), and each scale of the instrument measures differences in students' perceptions that are more a result of between class differences than within class differences (significant ANOVA eta^2 coefficients).

However, because of the circumplex nature of the QTI (Section 2.3.3), the scales adjacent to one another do measure quite similar dimensions of student-teacher interpersonal behaviour and so strong scale correlations are expected. The further apart any two scales are on the circumplex model, the weaker their correlations should be, with negative correlations being recorded between scales diametrically opposed on the model.

Tables 4.1 and 4.2 report the reliability and validity statistics for the 48-item Australian Form of the QTI used with the target sample of 208 students in 12 science classes. Due to the sample size, analyses were carried out using only the individual student as the unit of analysis.

Table 4.1

Internal Consistency (Cronbach Alpha Coefficient) and Ability to Differentiate Between Classrooms for the QTI

Scale	Alpha Reliability		ANOVA Results (eta^2)
	Actual	Preferred	Actual
Leadership (Lea)	0.87	0.95	0.20**
Helping/Friendly (HFr)	0.94	0.93	0.29**
Understanding (Und)	0.88	0.96	0.23**
Student Responsibility (SRe)	0.89	0.92	0.26*
Uncertain (Unc)	0.89	0.95	0.05
Dissatisfied (Dis)	0.93	0.95	0.11**
Admonishing (Adm)	0.94	0.95	0.34**
Strict (Str)	0.82	0.96	0.23*

* $p < 0.05$ ** $p < 0.01$ N = 208

Scale internal consistencies were confirmed by the calculation of Cronbach (1951) alpha coefficients for each scale. Table 4.1 reveals that the alpha reliability figures for different scales in the Actual Form of the QTI range from 0.82 to 0.94 while in the Preferred Form they range from 0.92 to 0.96. These figures are well above the threshold value of 0.6 which Nunnally (1967) identified as an indicator of acceptable reliability for research purposes. These figures are also in accordance with those obtained from a previous study involving Australian students (Henderson, Fisher, & Fraser, 1995). In this study, for the Preferred Form of the QTI, alpha reliability figures for the different scales ranged from 0.59 to 0.76 when the individual student was used as the unit of analysis.

Another characteristic of the QTI that was investigated in this study was the ability of each scale to differentiate between the perceptions of students in different classes. This was determined using the one-way ANOVA eta^2 statistic for each scale, with class membership as the main effect. As shown in the last column of Table 4.1, this

analysis revealed statistically significant differences between the perceptions of students in different classes for all QTI scales except Uncertain. The ANOVA eta^2 values for the Actual Form of the QTI for this component of the study indicate that the amount of variance explained by class membership ranges from 0.05 to 0.34. These values compare favourably with those reported for one of the first Australian studies (Fisher, Henderson, & Fraser, 1995) providing this statistic for the 48-item Australian Actual Form of the QTI where the values ranged from 0.20 to 0.48 as well as for a more recent study (Fisher, Fraser, & Rickards, 1997) where the values ranged from 0.22 to 0.35.

Interscale correlations can be used to test the validity of the circular two-dimensional model on which the QTI is based. This model would be validated if interscale correlations were highest between adjacent scales and lowest between scales opposite to one another on the model. Table 4.2 reports interscale correlations for Actual and Preferred Forms of the QTI with the individual student as the unit of analysis. The figures from this study validate the circumplex pattern of the QTI in that, with a few minor exceptions, the highest correlations are found between scales adjacent on the two-dimensional model (e.g., between helping/friendly and leadership behaviour) and the lowest correlations between scales opposite to one another on the model (e.g., between helping/friendly and dissatisfied behaviour).

Table 4.2

Correlations (Pearson) Between Scales for Actual and Preferred Forms of the QTI

Scale	HFr		Und		SRe		Unc		Dis		Adm		Str	
	Act	Pre	Act	Pre	Act	Pre	Act	Pre	Act	Pre	Act	Pre	Act	Pre
Lea	0.64	0.55	0.70	0.68	0.09	-0.05	-0.40	-0.57	-0.41	-0.45	-0.38	-0.49	-0.12	-0.12
HFr			0.75	0.56	0.39	0.19	-0.38	-0.35	-0.51	-0.65	-0.61	-0.50	-0.35	-0.43
Und					0.31	0.16	-0.34	-0.37	-0.49	-0.46	-0.55	-0.49	-0.38	-0.25
SRe							0.24	0.28	0.06	-0.01	-0.19	-0/03	-0.25	-0.31
Unc									0.52	0.57	0.49	0.64	0.21	0.21
Dis											0.59	0.63	0.41	0.60
Adm													0.48	0.49

The pattern of interscale correlations is illustrated in Figure 4.1 where correlations between the Dissatisfied scale and the seven other scales of the QTI (using figures from the Actual Form of the instrument with the individual student as the unit of

analysis) reveal highest correlations with scales adjacent to Dissatisfied behaviour on the circumplex model (Admonishing and Uncertain behaviour) and the lowest correlation with the Helping/Friendly scale, opposite to Dissatisfied on the model.

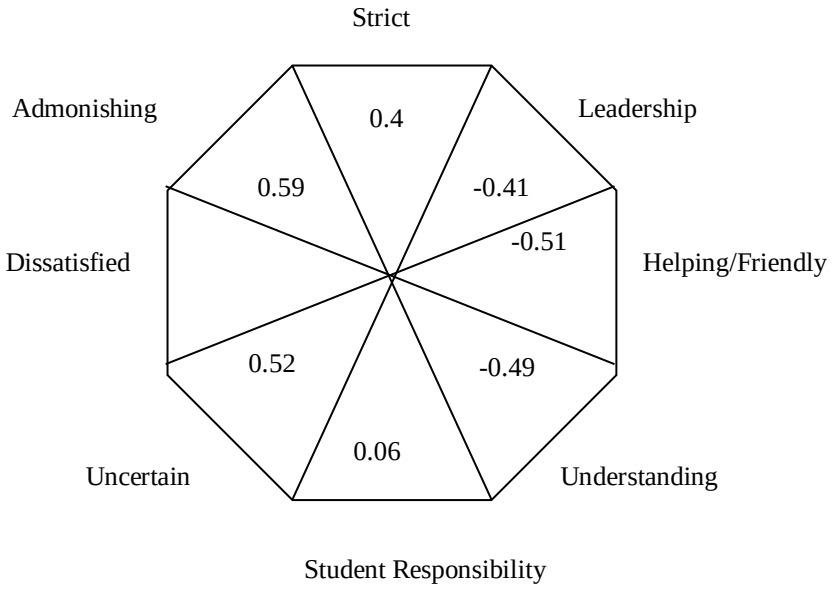

Figure 4.1. Correlations between Dissatisfied and the other scales of the QTI, using the Actual Form of the instrument with the individual student as the unit of analysis.

4.2.2 Reliability and Validity of the SLEI

Table 4.3 reports three reliability and validity statistics for student responses to the 35-item Form of the SLEI used in this study. Statistics relating to the instrument's internal consistency, discriminant validity and ability to differentiate between the perceptions of students in different classrooms are reported for both Actual and Preferred Forms with the individual student as the unit of analysis. It shows that, for the Actual Form of the SLEI, the alpha reliability figures ranged from 0.75 to 0.87 and that, for the Preferred Form of the SLEI they ranged from 0.75 to 0.88. All scales have acceptable reliability for research purposes.

The mean correlation of a scale with other scales was used as a convenient measure of the discriminant validity of the SLEI. As shown in Table 4.3, for the Actual Form, mean correlations ranged from 0.15 to 0.29 while for the Preferred Form, figures ranged from 0.10 to 0.24. These discriminant validity values indicate that the

SLEI measures distinct aspects of the laboratory learning environment, as previously reported by Fraser et al. (1993).

As previously indicated, it is desirable that classroom environment instruments are able to discriminate between the perceptions of students in different classes. The eta^2 values reported in Table 4.3 range from 0.06 to 0.33 but only the Student Cohesiveness, Open-endedness and Material Environment scales differentiated significantly (p<0.01) between the perceptions of students in different classes.

Table 4.3

Internal Consistency (Cronbach Alpha Coefficient) and Ability to Differentiate Between Classrooms for the SLEI

Scale	Alpha Reliability		Mean correlation with other scales		ANOVA Results (eta^2)
	Actual	Preferred	Actual	Preferred	
Student Cohesiveness (SC)	0.79	0.78	0.21	0.24	0.13**
Open-endedness (OE)	0.75	0.88	0.29	0.24	0.13**
Integration (I)	0.76	0.80	0.26	0.15	0.06
Rule Clarity (RC)	0.87	0.81	0.24	0.20	0.09
Material Environment (ME)	0.80	0.75	0.15	0.10	0.33**

** p< 0.01 N= 208

4.3 FEEDBACK PHASE

4.3.1 Student Perceptions of Interpersonal Teacher Behaviour

As previously mentioned, each of the 48 items of the Australian Form of the QTI is allocated to one of the eight scales (Leadership, Helping/Friendly, Understanding, Student Responsibility, Uncertain, Dissatisfied, Admonishing and Strict) with each scale having six items. To enable comparisons between student perceptions of actual and preferred teacher-student interpersonal behaviour, the item mean was determined for each scale. The item mean is calculated by adding the individual students' scores for each item in the scale and dividing by the product of the number of items in the scale and the number of students whose responses were included in the calculation. Because of the way student responses are coded, its value will be

between 0 and 4. These item means, with the individual as the unit of analysis, are presented in Table 4.4. To further facilitate comparison between students' actual and preferred perceptions, the item means for each scale are presented graphically in Figure 4.2.

Table 4.4

Item Means and Standard Deviations for Actual and Preferred Forms of the QTI

Scale	Actual		Preferred		Difference
	Item Mean	Standard Deviation	Item Mean	Standard Deviation	(P – A)
Leadership	2.43	0.66	3.22	0.71	0.79 ***
Helping/Friendly	2.35	0.87	3.49	0.71	1.14 ***
Understanding	2.40	0.79	3.45	0.73	1.05 ***
Student Responsibility	1.54	0.66	2.45	0.77	0.91 ***
Uncertain	1.11	0.67	1.04	0.89	-0.07
Dissatisfied	1.40	0.80	0.82	0.89	-0.58 ***
Admonishing	1.68	0.88	0.95	0.90	-0.73 ***
Strict	1.94	0.64	1.32	0.84	-0.62 ***

* * * $p < 0.001$ N = 208

The data depicted in Figure 4.2 indicate that, relative to the actual environment at the time of data collection, students' prefer teachers who show stronger leadership, who are more helpful, friendly and understanding, and who give them more responsibility and freedom. Students also prefer teachers who are less dissatisfied, admonishing and strict.

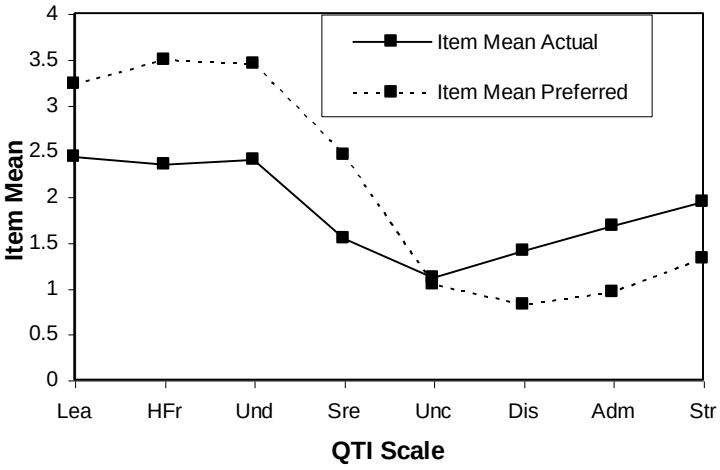

Figure 4.2. Item means for actual and preferred forms of the QTI.

Data presented and discussed so far in this section refer to the whole group of students involved in the study. To provide a more detailed picture of the perceptions of students, similar analyses were carried out for a variety of subgroups. Tables 4.5 to 4.8 contain item means for the Actual and Preferred Forms of the QTI for subgroups based on individual teacher, student result, gender and year level. Analysis of student perceptions of teacher interpersonal behaviours for these subgroups was considered important as teachers planned for the intervention phase of the study. These analyses provide additional background information for discussions relating to aspects of the classroom environment which may be targeted for change. Graphical analyses of these data are presented in Figures 4.3 to 4.6.

Students from 12 junior science classes completed the Actual and Preferred Forms of the QTI. Four teachers (identified as A, B, C and D) were timetabled onto one or more of these classes. Because the QTI focuses on the interpersonal behaviours of teachers it was considered worthwhile comparing student perceptions of the actual interpersonal behaviours exhibited by each of the teachers with the interpersonal teacher behaviours students associated with their preferred teacher. As can be seen from Table 4.5, which presents QTI scale mean and standard deviation data relating to each teacher, with the exception of the Uncertain scale for all teachers and the Dissatisfied scale for Teacher D, the mean differences for each teacher for each scale are statistically significant to at least $p<0.05$. Figure 4.3, which graphically portrays the data presented in Table 4.5, shows that student perceptions about the interpersonal behaviours of each teacher are relatively similar, although the behaviours exhibited by Teacher B are generally closer to those preferred by students than are the behaviours exhibited by the other participating teachers. Regardless of who their teacher is, students prefer teachers who exhibit stronger leadership, who are more helpful, friendly and understanding, and who give them more responsibility and freedom. Students also prefer their teachers to exhibit behaviours which indicate that they are less dissatisfied, admonishing and strict. For Teacher A, the largest actual/preferred differences occurred on the Helping/Friendly and Understanding scales. For Teacher B, the Student Responsibility and Helping/Friendly scales were identified as having the highest actual/preferred discrepancies while for Teacher C it was the Understanding and Helping/Friendly scales. With Teacher D, the major actual/preferred differences occurred on the Understanding and Student

Table 4. 5

Item Means for the Actual and Preferred Forms of the QTI for the Individual Teacher Subgroup of the Whole Sample

Scale	Individual Teacher											
	A			B			C			D		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Leadership	2.33	3.25	0.92 ***	2.72	3.12	0.40 *	2.41	3.17	0.76 ***	2.32	3.34	1.02 ***
Helping/Friendly	2.10	3.47	1.37 ***	2.75	3.38	0.63 ***	2.54	3.72	1.18 ***	2.19	3.36	1.17 ***
Understanding	2.20	3.49	1.29 ***	2.76	3.30	0.54 ***	2.51	3.40	0.89 ***	2.23	3.64	1.41 ***
Student Responsibility	1.54	2.44	0.90 ***	1.81	2.63	0.82 ***	1.52	2.35	0.83 ***	1.20	2.39	1.19 ***
Uncertain	1.15	0.85	-0.30	1.00	1.30	0.30	1.10	1.08	-0.02	1.19	1.08	-0.11
Dissatisfied	1.48	0.72	-0.76 ***	1.41	0.93	-0.48 *	1.32	0.79	-0.53 ***	1.30	0.97	-0.33
Admonishing	1.92	0.90	-1.02 ***	1.35	1.05	-0.30 *	1.40	0.90	-0.50 ***	1.96	1.05	-0.91 ***
Strict	1.97	1.23	-0.74 ***	1.71	1.28	-0.43 *	1.93	1.32	-0.61 ***	2.16	1.60	-0.56 *

* $p < 0.05$ *** $p < 0.001$ N = 208

Responsibility scales. When each teacher considers which interpersonal behaviours to target for change, this information should be considered.

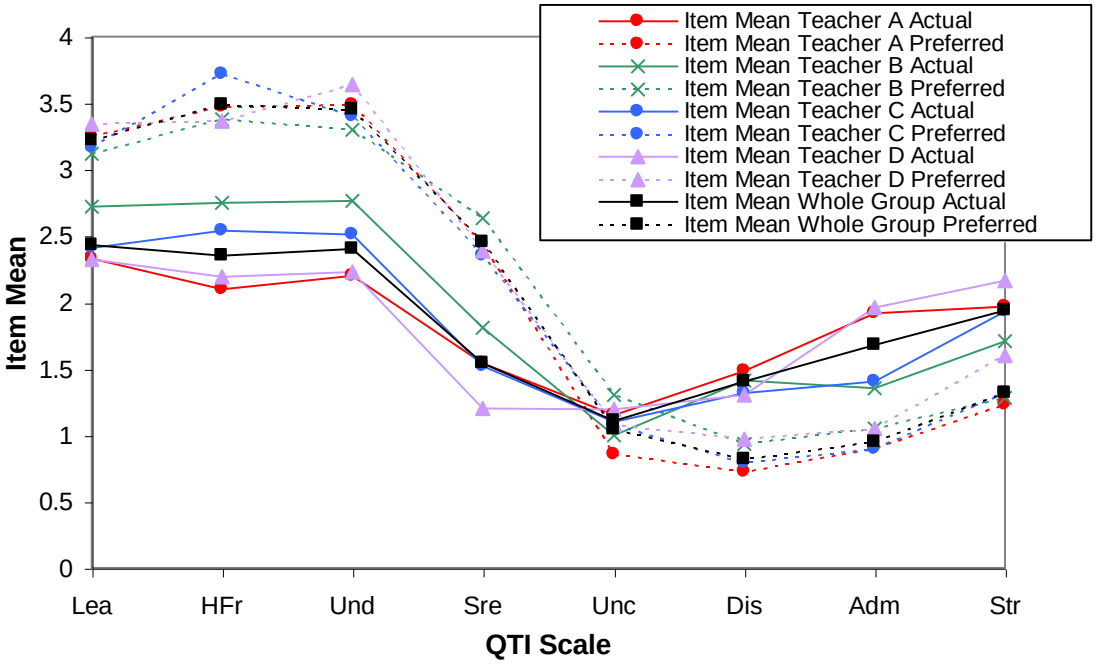

Figure 4.3. Item means for the actual and preferred forms of the QTI based on student perceptions of individual teachers compared with item means for the whole group.

Based on their academic performance students are awarded one of five levels of achievement – very high achievement (VHA), high achievement (HA), sound achievement (SA), limited achievement (LA) or very limited achievement (VLA). When considering differences between preferred and actual means for each scale for each level of achievement, the information provided in Table 4.6 shows which differences are statistically significant. From the data depicted in Figure 4.4, it can be seen that regardless of the level of achievement attained by a student, they prefer teachers who exhibit more leadership, helping/friendly and understanding behaviours than they perceive their actual teachers to exhibit. They also prefer teachers who allow more responsibility and freedom. Perceptions of VHA students identified the largest actual/preferred discrepancies on the Leadership and Helping/Friendly scales while for VLA students it was the Student Responsibility and Helping/Friendly scales where the largest actual/preferred differences occurred. For students

Table 4. 6

Item Means for the Actual and Preferred Forms of the QTI for the Result Subgroup of the Whole Sample

Scale	Result														
	VHA			HA			SA			LA			VLA		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Leadership	2.62	3.62	1.00 ***	2.51	3.46	0.95 ***	2.40	3.25	0.85 ***	2.41	3.17	0.76 ***	2.42	3.10	0.68 ***
Helping/Friendly	2.77	3.59	0.82 **	2.64	3.78	1.14 ***	2.44	3.60	1.16 ***	2.30	3.54	1.24 ***	2.17	3.22	1.05 ***
Understanding	2.79	3.38	0.59	2.54	3.83	1.29 ***	2.38	3.49	1.11 ***	2.41	3.48	1.07 ***	2.28	3.28	1.00 ***
Student Responsibility	1.62	2.14	0.52	1.78	2.24	0.46	1.58	2.48	0.90 ***	1.58	2.50	0.92 ***	1.37	2.48	1.11 ***
Uncertain	0.98	0.62	-0.36	0.98	0.86	-0.12	1.15	0.89	-0.26 *	1.10	1.07	-0.03	1.17	1.25	0.08
Dissatisfied	0.97	0.38	-0.59 *	0.93	0.30	-0.63 **	1.39	0.59	-0.80 ***	1.49	0.83	-0.66 **	1.52	1.26	-0.26
Admonishing	1.09	0.36	-0.73 **	1.28	0.52	-0.76 **	1.62	0.91	-0.71 ***	1.75	0.91	-0.84 ***	1.88	1.29	-0.59 **
Strict	1.80	1.03	-0.77 ***	1.55	0.69	-0.86 ***	1.91	1.17	-0.74 ***	2.00	1.27	-0.73 ***	2.01	1.78	-0.23

* $p < 0.05$ ** $p < 0.01$ * * * $p < 0.001$ N = 208

achieving HA, SA or LA the major actual/preferred differences occurred on the Helping/Friendly and Understanding scales. Regardless of the level of achievement obtained by a student, the Helping/Friendly scale consistently had significant actual/preferred differences.

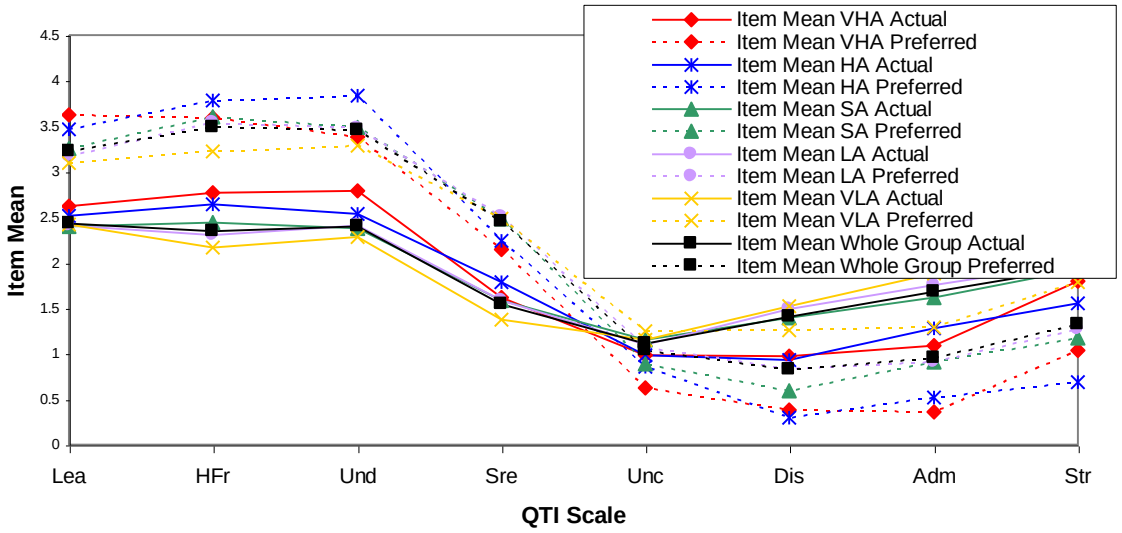

Figure 4.4. Item means for the actual and preferred forms of the QTI based on perceptions of students obtaining different results compared with item means for the whole group.

Table 4.7 reports the scale means and standard deviations for male and female student responses to the Actual and Preferred Forms of the QTI. Preferred/actual differences in scale means for both male and female students are also shown in Table 4.7. With the exception of the Uncertain scale for male students, all other scale mean differences are statistically significant. The data presented in Table 4.7 are portrayed graphically in Figure 4.5. Both male and female students prefer teachers who exhibit more leadership qualities as well as those who are more helpful, friendly and understanding and less strict, admonishing and dissatisfied than they perceive their actual teachers to be. They also prefer teachers who allow them to have more responsibility and freedom in their science classes. For male students, greater actual/preferred differences were identified on the Helping/Friendly, Understanding and Student Responsibility scales while for female students it was the Helping/Friendly, Understanding and Leadership scales where the largest actual/preferred discrepancies occurred.

Table 4. 7

Item Means for the Actual and Preferred Forms of the QTI for the Gender Subgroup of the Whole Sample

Scale	Gender					
	Male			Female		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Leadership	2.43	3.12	0.69 ***	2.43	3.31	0.88 ***
Helping/Friendly	2.22	3.39	1.17 ***	2.48	3.59	1.11 ***
Understanding	2.31	3.38	1.07 ***	2.48	3.52	1.04 ***
Student Responsibility	1.54	2.59	1.05 ***	1.54	2.32	0.78 ***
Uncertain	1.23	1.30	0.07	1.01	0.79	-0.22 **
Dissatisfied	1.59	1.04	-0.55 ***	1.23	0.61	-0.62 ***
Admonishing	1.88	1.15	-0.73 ***	1.49	0.77	-0.72 ***
Strict	2.03	1.38	-0.65 ***	1.84	1.26	-0.58 ***

** $p < 0.01$ *** $p < 0.001$ N = 208

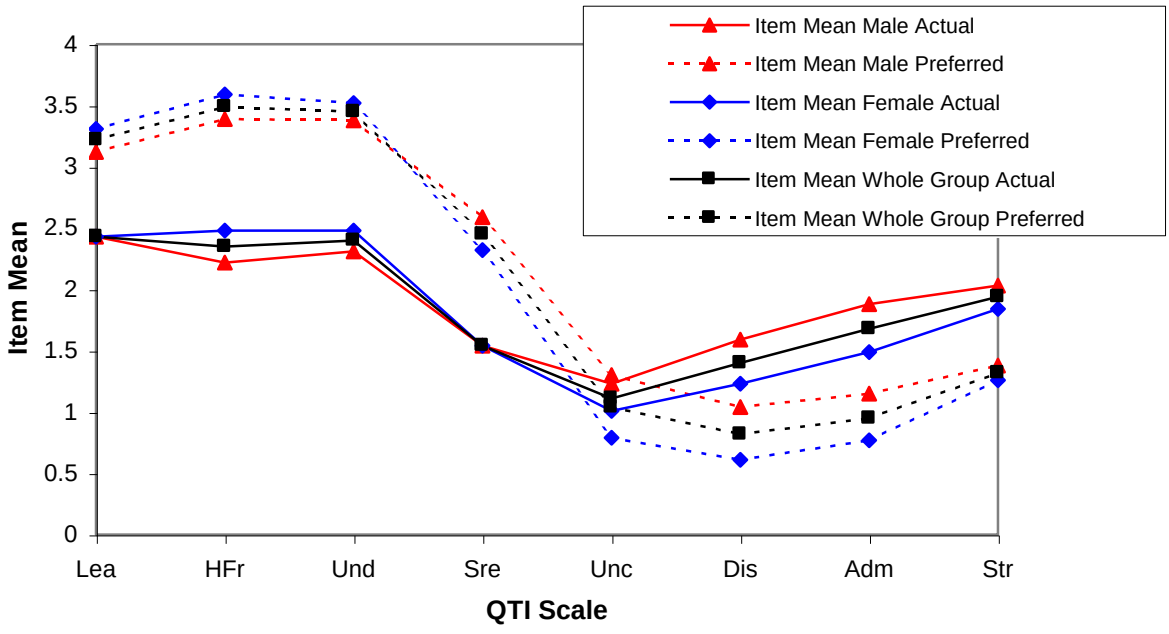

Figure 4.5. Item means for the actual and preferred forms of the QTI based on perceptions of male and female students compared with item means for the whole group.

Table 4.8 provides data obtained from students according to their year level. Except for the Uncertain scale, preferred/actual mean differences for each scale for each year level were statistically significant. Figure 4.6 indicates that regardless of the year level a student is in, they still prefer their teacher to display more leadership, to be more helping/friendly and understanding and to allow them more responsibility and freedom. They also prefer classroom environments where the teacher exhibits less dissatisfied, admonishing and strict behaviours. Students from all three year levels identified largest actual/preferred discrepancies on the Helping/Friendly and Understanding scales.

Table 4.8

Item Means for the Actual and Preferred Forms of the QTI for the Year Level Subgroup of the Whole Sample

Scale	Year Level								
	8			9			10		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Leadership	2.28	3.19	0.91 ***	2.61	3.29	0.68 ***	2.40	3.15	0.75 ***
Helping/Friendly	2.08	3.56	1.48 ***	2.70	3.58	0.88 ***	2.27	3.29	1.02 ***
Understanding	2.15	3.43	1.28 ***	2.67	3.54	0.87 ***	2.38	3.36	0.98 ***
Student Responsibility	1.43	2.56	1.13 ***	1.69	2.50	0.81 ***	1.49	2.24	0.75 ***
Uncertain	1.13	1.01	-0.12	1.03	0.96	-0.07	1.20	1/17	-0.03
Dissatisfied	1.65	0.79	-0.86 ***	1.10	0.66	-0.44 ***	1.46	1.08	-0.38 **
Admonishing	1.82	0.97	-0.85 ***	1.31	0.75	-0.56 ***	1.99	1.20	-0.79 ***
Strict	2.04	1.26	-0.78 ***	1.79	1.25	-0.54 ***	1.99	1.51	-0.48 **

** $p < 0.01$ *** $p < 0.001$ N = 208

Consideration of the QTI data obtained for each of the subgroups provides teachers participating in the study with some insights into the perceptions and preferences of particular groups of students. Key findings are summarised in Section 4.4 of this chapter and considered by teachers as they develop and implement their classroom environment improvement plans.

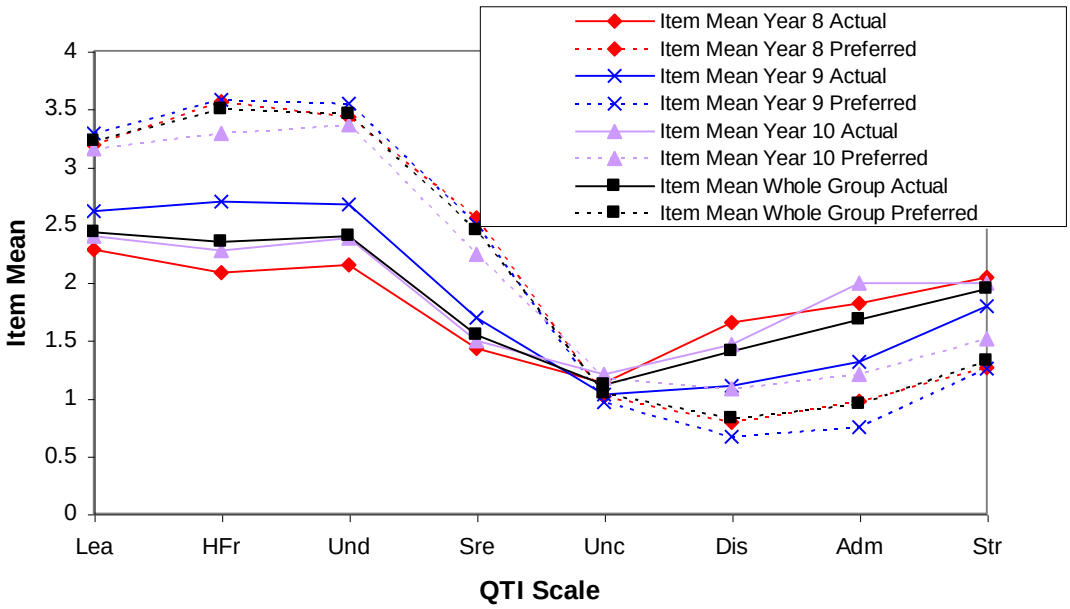

Figure 4.6. Item means for the actual and preferred forms of the QTI based on perceptions of students in different year levels compared with item means for the whole group.

4.3.2 Student Perceptions of the Science Laboratory Learning Environment

The SLEI contains 35 items, each of which is allocated to one of 5 scales – Student Cohesiveness, Open-endedness, Integration, Rule Clarity and Material Environment. Each scale contains seven items. Item mean scores, calculated for each scale of both the Actual and Preferred Forms of the SLEI, are presented in Table 4.9. Students responded to items on a five-point scale from 1 to 5 so item mean scores fall within this range. The item means for each scale are also presented graphically in Figure 4.7.

Table 4.9

Item Means and Standard Deviations for Actual and Preferred Forms of the SLEI

Scale	Actual		Preferred		Difference
	Item Mean	Standard Deviation	Item Mean	Standard Deviation	(P - A)
Student Cohesiveness	3.04	0.49	3.55	0.53	0.50 **
Open-endedness	2.52	0.48	3.40	0.59	0.88 **
Integration	2.58	0.44	2.91	0.51	0.33 **
Rule Clarity	3.43	0.57	3.50	0.59	0.07 **
Material Environment	2.88	0.41	2.94	0.46	0.06 **

** $p < 0.01$ N = 208

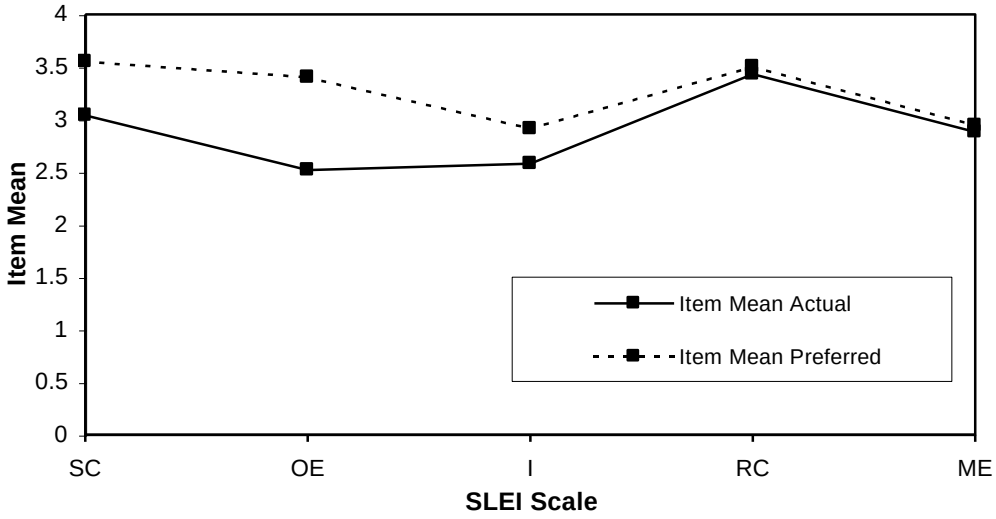

Figure 4.7. Item means for actual and preferred forms of the SLEI.

The data portrayed in Figure 4.7 clearly indicate that, in comparison with the actual environment, students prefer to work in a science laboratory environment where there are higher levels of student cohesiveness, open-endedness, integration and rule clarity and a better material environment. In particular, the preferred/actual mean differences are larger for the Student Cohesiveness, Open-endedness and Integration scales. These results replicate the findings of previous studies using the SLEI (Giddings & Fraser, 1990) and a modified form of the SLEI, the *Chemistry Laboratory Environment Inventory* [CLEI] (Wong & Fraser, 1994), which showed that students prefer a more positive learning environment with regard to all five scales of the instrument.

To provide additional data relating to student perceptions of their science laboratory environment, analyses were carried out with different subgroups of students based on gender, teacher, year level and achievement. Tables 4.10 to 4.13 contain scale means and standard deviations for the Actual and Preferred Forms of the SLEI for each of these. Analysis of student perceptions of the science laboratory environment for these subgroups was considered important as teachers planned for the intervention phase of the study. These analyses provide additional background information for discussions relating to aspects of the classroom environment which may be targeted for change. Graphical analyses of these data are presented in Figures 4.8 to 4.11.

Table 4.10

Item Means for the Actual and Preferred Forms of the SLEI for the Individual Teacher Subgroup of the Whole Sample

Scale	Individual Teacher											
	A			B			C			D		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Student Cohesiveness	3.06	3.64	0.58 ***	2.94	3.41	0.47 **	3.09	3.63	0.54 ***	3.01	3.42	0.41 **
Open-endedness	2.48	3.49	1.01 ***	2.58	3.31	0.73 ***	2.56	3.47	0.91 **	2.46	3.17	0.71 ***
Integration	2.56	2.93	0.37 ***	2.67	2.98	0.31 **	2.58	2.85	0.27 **	2.51	2.86	0.35 *
Rule Clarity	3.39	3.56	0.17	3.53	3.41	-0.12	3.36	3.50	0.14	3.48	3.45	-0.03
Material Environment	2.88	2.89	0.01	2.94	2.99	0.05	2.88	2.96	0.08	2.80	2.96	0.16

* $p < 0.05$ ** $p < 0.01$ * * * $p < 0.001$ N = 208

As can be seen from Table 4.10, when each teacher is considered separately, preferred/actual differences are only statistically significant for the Student Cohesiveness, Open-endedness and Integration scales. Data presented in this table are graphically portrayed in Figure 4.8. Regardless of their teacher, students perceive their actual laboratory environments to be very similar. Regardless of the teacher, students identified the largest actual/preferred differences as occurring for the Open-endedness and Student Cohesiveness scales.

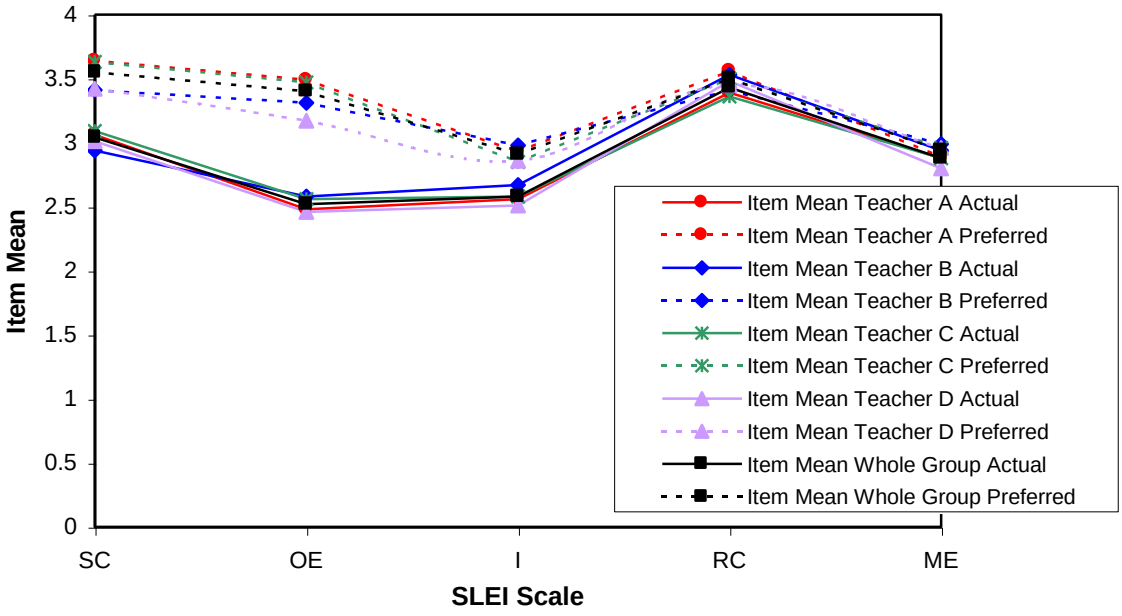

Figure 4.8. Item means for the actual and preferred forms of the SLEI based on student perceptions of individual teachers compared with item means for the whole group.

Data based on student achievement are presented in Table 4.11 and related graphs in Figure 4.9. Preferred/actual mean differences for each level of achievement are statistically significant for the Open-endedness and Integration scales, as well as the Student Cohesiveness scale for all achievement levels except HA. From Figure 4.9 it can be seen that regardless of the level of achievement of a student, their perception of their actual laboratory environment is relatively similar for all SLEI scales. For students obtaining VHA, SA or LA the largest actual/preferred mean differences occurred on the Open-endedness and Student Cohesiveness scales while for HA and VLA students the largest discrepancies occurred on the Open-endedness and Integration scales.

Table 4.11

Item Means for the Actual and Preferred Forms of the SLEI for the Result Subgroup of the Whole Sample

Scale	Result														
	VHA			HA			SA			LA			VLA		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Student Cohesiveness	2.97	3.60	0.63 ***	3.14	3.44	0.30	2.99	3.68	0.69 ***	3.02	3.60	0.58 ***	3.09	3.41	0.32 **
Open-Endedness	2.55	3.38	0.83 *	2.50	3.64	1.14 ***	2.53	3.46	0.93 ***	2.53	3.49	0.96 ***	2.49	3.16	0.67 ***
Integration	2.55	3.03	0.48 *	2.54	2.98	0.44 **	2.57	2.82	0.25 **	2.66	2.88	0.22 **	2.49	3.00	0.51 ***
Rule Clarity	3.45	3.58	0.13	3.36	3.57	0.21	3.39	3.60	0.21	3.50	3.43	-0.07	3.37	3.45	0.08
Material Environment	2.83	2.96	0.13	2.82	3.11	0.29	2.89	2.88	-0.01	2.93	2.91	-0.02	2.85	2.97	0.12

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ N = 208

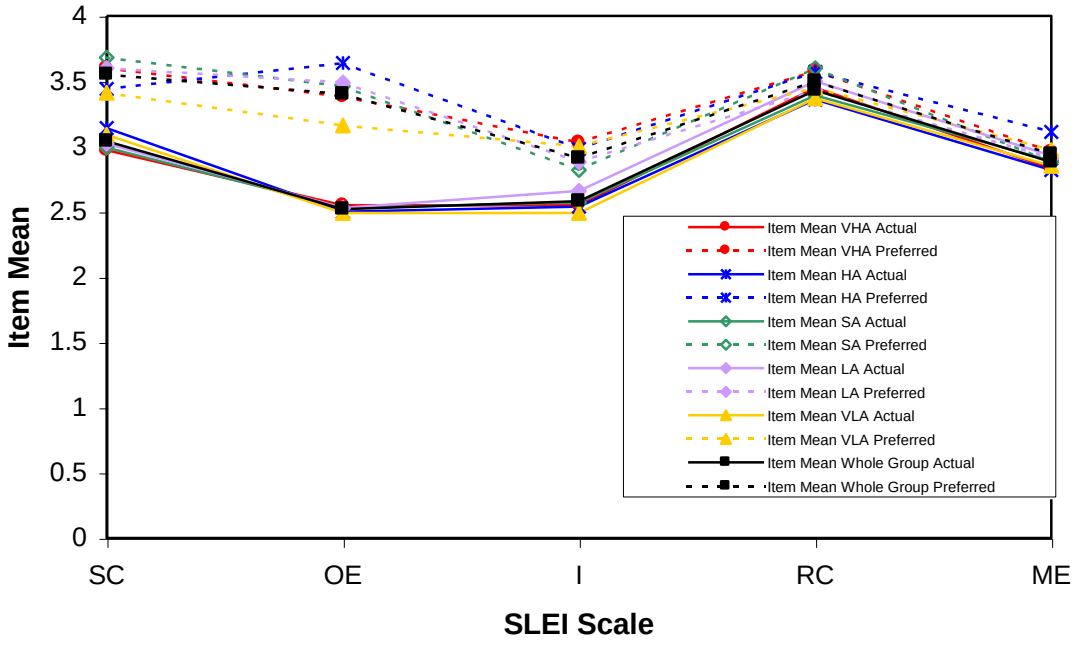

Figure 4.9. Item means for the actual and preferred forms of the SLEI based on perceptions of students obtaining different results compared with item means for the whole group.

Table 4.12 depicts data obtained separately from male and female students in response to Actual and Preferred Forms of the SLEI. Preferred/actual mean differences for both genders are significant for the Student Cohesiveness, Open-endedness and Integration scales. As shown in Figure 4.10, male and female students perceive their actual science laboratory environments to be very similar.

Table 4.12
Item Means for the Actual and Preferred Forms of the SLEI for the Gender Subgroup of the Whole Sample

Scale	Gender					
	Male			Female		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Student Cohesiveness	3.06	3.52	0.46 ***	3.02	3.58	0.56 **
Open-endedness	2.56	3.49	0.93 ***	2.48	3.31	0.83 ***
Integration	2.62	3.01	0.39 ***	2.54	2.82	0.28 ***
Rule Clarity	3.42	3.44	0.02	3.43	3.55	0.12
Material Environment	2.93	3.00	0.07	2.84	2.88	0.04

*** $p < 0.001$ N = 208

For both male and female students the largest actual/preferred differences occurred for the Open-endedness and Student Cohesion scales.

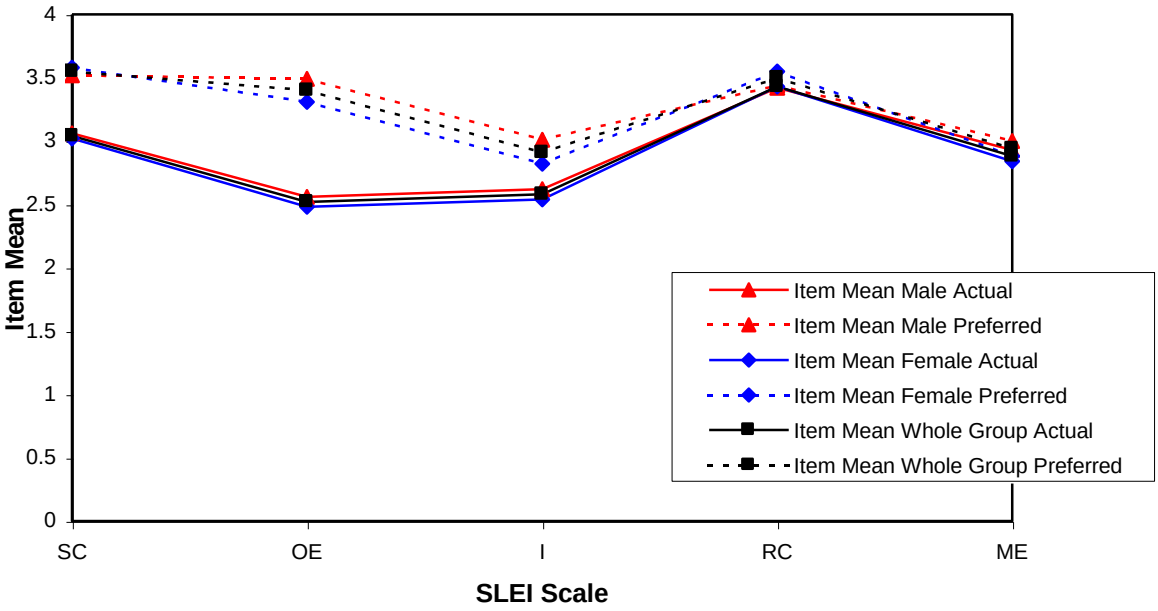

Figure 4.10. Item means for the actual and preferred forms of the SLEI based on perceptions of male and female students compared with item means for the whole group.

When considering data obtained from students in different year levels, as shown in Table 4.13, preferred/actual mean differences are statistically significant for the Student Cohesiveness, Open-endedness and Integration scales. Figure 4.11 graphically depicts the data presented in Table 4.13. From this figure it can be seen that students from all year levels prefer very similar laboratory environments. Regardless of their year level, students identified larger actual/preferred mean differences on the Open-endedness and Student Cohesiveness scales.

Table 4.13

Item Means for the Actual and Preferred Forms of the SLEI for the Year Level Subgroup of the Whole Sample

Scale	Year Level								
	8			9			10		
	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)	Act	Pre	Diff (P-A)
Student Cohesiveness	3.05	3.62	0.57 ***	3.01	3.50	0.49 ***	3.06	3.54	0.48 ***
Open-Endedness	2.36	3.43	1.07 ***	2.64	3.42	0.78 ***	2.58	3.33	0.75 ***
Integration	2.54	2.93	0.39 ***	2.63	2.88	0.25 ***	2.58	2.92	0.34 ***
Rule Clarity	3.53	3.49	+0.04	3.39	3.48	0.09	3.34	3.53	0.19
Material Environment	2.90	2.97	0.07	2.98	2.89	+0.09	2.73	2.96	0.23

*** $p < 0.001$ N = 208

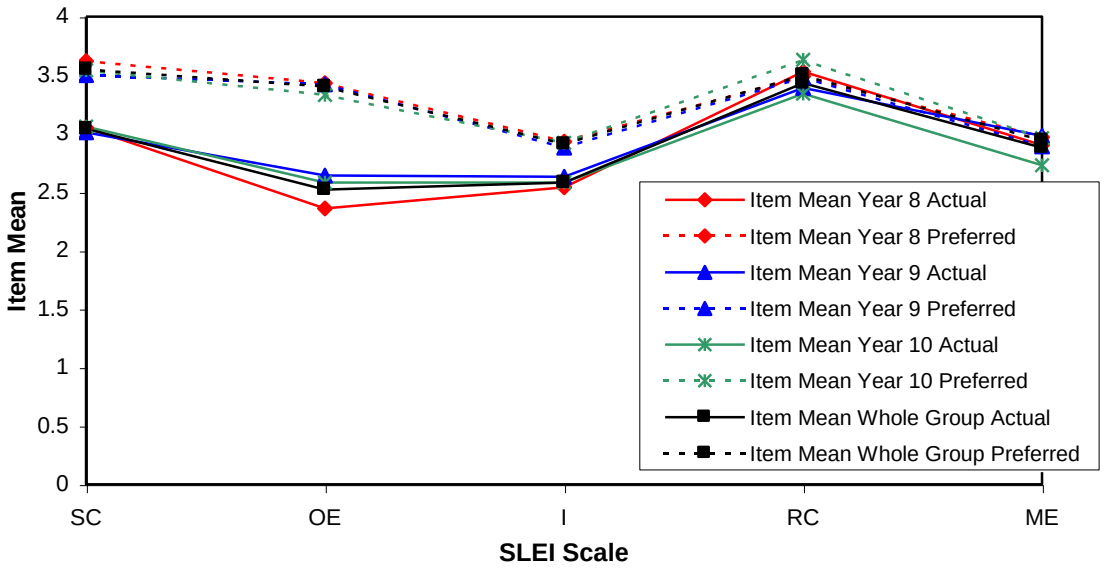

Figure 4.11. Item means for the actual and preferred forms of the SLEI based on perceptions of students in different year levels compared with item means for the whole group.

From the data presented in this section and the related discussions, all subgroups perceive their actual laboratory environments to be similar in relation to all characteristics investigated by the SLEI. While for the whole group of students who responded to the Actual and Preferred Forms of the SLEI preferred/actual differences were statistically significant for each SLEI scale, when the subgroups were considered the preferred/actual differences were not statistically significant for any

subgroup for the Rule Clarity and Material Environment scales. This is an important consideration when determining which aspects of the laboratory environment are going to be targeted for change in the intervention phase of the study. Key findings are summarised in Section 4.4 of this chapter and considered by teachers as they develop and implement their classroom environment improvement plans.

In preparation for the next stage of the study – the reflection and discussion phase, each of the four science teachers whose classes had responded to the Actual and Preferred Forms of the QTI and SLEI was provided with a package containing the following:

1. copies of the Actual and Preferred Forms of the QTI and SLEI
2. background information relating to each scale of the QTI and SLEI
3. copies of Figures 4.2 to 4.11, each annotated to explain the information it provided
4. a summary of the data analysis.

4.4 REFLECTION AND DISCUSSION PHASE

The following points summarise the data analysis carried out and reported in the previous section of this chapter.

(a) Interpersonal Teacher Behaviour

In relation to their perceptions of actual interpersonal behaviours exhibited by their teachers, students prefer teachers who:

* display greater leadership
* are more helping, friendly and understanding
* give them more responsibility and freedom
* display less dissatisfied, admonishing and strict behaviours.

When analysing the data for subgroups of the whole student group based on individual teachers, the year level of the student, the gender of the student and the result achieved by the student it was found that:

* regardless of the subgroup, students preferred teachers who demonstrated stronger leadership, were more helping, friendly and understanding and

provided students with more responsibility and freedom. They also preferred teachers who were less dissatisfied, admonishing and strict.

* for Teacher A, the largest actual/preferred discrepancy was for the Helping/Friendly scale while for Teacher B it was for the Student Responsibility scale. For Teachers C and D, the Understanding scale had the largest actual/preferred differences.
* regardless of the level of achievement obtained by a student, the Helping/Friendly scale consistently had significant actual/preferred differences even though these differences may not have been the largest for all levels of achievement.
* for both male and female students the largest actual/preferred differences occurred on the Helping/Friendly scale.
* regardless of the year level of a student, the Helping/Friendly scale had the largest actual/preferred differences.

(b) Science Laboratory Environments

In relation to their perceptions of the characteristics of their actual laboratory environments, students prefer environments where there is:

* more student cohesiveness i.e. students know each other better and provide more help and support for each other
* considerably more open-endedness i.e. more emphasis on laboratory activities which emphasise an open-ended divergent approach rather than a follow-the-recipe approach to experimentation
* more integration i.e. an increased focus on the relationship between laboratory activities and the non-laboratory and theory components of the subject
* slightly more rule clarity i.e. an increase in the extent to which behaviour in the laboratory is guided by formal rules
* a slightly better material environment i.e. better access to laboratory equipment and materials which meet the needs of students.

Regardless of the subgroup considered, the findings were very similar to those of the whole group. However, it was found that:

* regardless of the subgroup, students preferred a science laboratory learning environment in which there was more open-endedness, student cohesion and integration
* regardless of the subgroup, the largest actual/preferred difference occurred for the Open-endedness scale.

After having an opportunity to reflect on the information provided as a result of the data analysis, the four teachers participating in the study met to discuss the findings and determine which aspects of the classroom environment they were going to target for change in the intervention phase of the study.

Given that one of the findings of this study for both teacher interpersonal behaviour and the laboratory environment was that student perceptions of their actual environment were similar regardless of who their teacher was, the teachers decided that they would all target the same aspects of their classroom environment in an attempt to reduce the difference between students' perceived actual and preferred environments. Even though each teacher would determine individual strategies for use in the intervention phase of the study, they felt that they would be able to better support each other if they were focussing on improving the same aspects of their classroom environments.

When deciding which aspects of the classroom environment were going to be targeted for change, each teacher was asked to consider two things. Firstly, that in the feedback phase of the study, a sizeable actual-preferred difference had been identified on the scale of the classroom environment instrument that related to that aspect of the classroom environment, and secondly, that they feel concerned enough about this difference to want to make an effort to reduce it.

In relation to the SLEI, the scale where the largest difference between student actual and preferred perceptions of the laboratory environment was identified was Open-endedness. It was decided that this would be one of the aspects of the classroom environment targeted for change. From the information provided after analysis of

the QTI data, the scales where there was greatest disparity between student perceptions of actual and preferred interpersonal teacher behaviours were Helping/Friendly, Understanding, Student Responsibility and Leadership. After significant discussion, the decision by the participating teachers was to target the Leadership scale.

4.5 INTERVENTION PHASE

As indicated in the previous section, the four teachers participating in the study identified the Leadership scale from the QTI and the Open-endedness scale from the SLEI as the aspects of their classroom environments they were going to target when implementing strategies to enhance the alignment of the actual and preferred classroom environment as perceived by students. Teachers also decided that, initially, they would select only one of their science classes to work with during this phase of the study.

Each teacher, with the support of their peers, was responsible for the development and implementation of their classroom environment improvement plan. As a starting point, for each of the targeted scales, they were challenged to suggest why there might be a significant difference between the actual and preferred learning environment as identified by students, and what changes needed to be made to reduce this difference.

To assist them respond to this challenge they were provided with some key information about the two targeted scales. For the Leadership scale from the QTI the following description of the typical behaviours associated with the scale was provided – notice what's happening, lead, organise, give orders, set tasks, determine procedure, structure the classroom situation, explain, hold attention. The Open-endedness scale from the SLEI was described as the extent to which the laboratory activities emphasise on open-ended divergent approach to experimentation. The teachers were also given a list of the items that made up the targeted scale on each instrument. These items are listed in Figures 4.12 and 4.13.

Items comprising the Leadership Scale of the QTI
This teacher talks enthusiastically about her/his subject.
This teacher explains things clearly.
This teacher holds our attention.
This teacher knows everything that goes on in the classroom.
This teacher is a good leader.
This teacher acts confidently.

Figure 4.12. Items comprising the leadership scale of the QTI.

Items comprising the Open-Ended Scale of the SLEI
There is opportunity for me to pursue my own science interests in this laboratory class.
In this laboratory class, I am required to design my own experiments to solve a given problem.
In my laboratory sessions, other students collect different data than I do for the same problem.
I am allowed to go beyond the regular laboratory exercise and do some experimenting of my own.
In my laboratory sessions, I do different experiments than some of the other students.
In my laboratory sessions, the teacher decides the best way for me to carry out the laboratory experiments.
I decide the best way to proceed during laboratory experiments.

Figure 4.13. Items comprising the open-endedness scale of the SLEI.

Details of the classroom environment improvement plan developed by each of the four participating teachers are provided in Section 4.5.1. The information provided stems from discussions between the researcher and the participating teachers, both on an individual and small group basis.

4.5.1 Classroom Environment Improvement Plans

Teacher A, a female in her second year of teaching, focussed on the QTI and SLEI items relating to the two targeted scales as she developed her improvement plan. Her specialist teaching area was biology and she felt that she would be better able to act confidently and talk enthusiastically about her subject if she could teach a unit of work that had a biology focus. She negotiated with the head of the science department to rearrange the order of the units of work for her selected class so that this could happen. When planning the unit she searched more extensively than usual

for resources and read more widely about the topic to increase her knowledge base. She also collected a supply of interesting snippets of relevant information to share with her students. In the classroom she paid particular attention to the verbal and non-verbal language she used in order to portray enthusiasm. When explaining new concepts to students she made an effort to cater for students in her class who had different preferred learning styles. In doing this she presented information in a wider variety of ways than she had previously, including notes on the whiteboard and overhead projector, verbal explanations, demonstrations, diagrams, tables and flowcharts. She also attempted to utilise the knowledge that students already had by encouraging them to be more involved in class discussions. In relation to holding the attention of students, she hoped that the wider variety of techniques she used to present information and the additional involvement of students in the teaching-learning process would address this. This teacher felt that she would never be aware of everything that went on in her classroom but that she could increase her awareness by moving around the room on a more regular basis and target individuals or groups of students who were off task or appeared to be experiencing difficulty completing set tasks.

The unit selected by Teacher A dealt with interactions in the environment. She organised a field trip to a local watercourse so that students could observe different habitats and collect information about their living and non-living components. The school-based aspects of the unit involved a combination of computer-based, laboratory-based and classroom-based activities. Most activities provided students with some degree of choice, even if it was only in the context of the activity.

While there was not a lot of scope for students to design their own experiments in this unit, Teacher A addressed some aspects of the Open-endedness scale of the SLEI. She provided some opportunities for students to pursue their own interests within the constraints of the unit by providing choice where possible. For example, when using computer simulations of different habitats students could select from habitats such as freshwater, marine, grassland or rainforest. This choice also meant that not every student was collecting the same data when carrying out similar activities, nor were they necessarily conducting the same experiments.

Teacher B, the head of the science department, has 15 years teaching experience and has been a head of department for nine years. QTI data collected from her classes showed that for the Leadership scale the actual interpersonal behaviours she displayed, as perceived by her students, were more closely aligned with those preferred by students than were those of the other teachers involved in the study. For this reason she decided to focus more on attempting to change the laboratory environment of her selected class than her leadership behaviours. She opted to work with a class studying a chemistry unit. Because of her expertise in chemistry she felt that she could readily display typical behaviours associated with the QTI Leadership scale through her attempts to make laboratory activities more open-ended.

Key aspects of the selected unit, Patterns of Interactions, provided students with opportunities to:

* identify patterns of change in substances that are being mixed or dissolved
* describe the patterns identified and justify the inferences made about these patterns
* predict changes that may occur when materials such as metals, aqueous solutions and indicators react
* plan and participate in investigations into the relationship between the rate of reaction and factors that affect the rate
* design and perform experiments that explore the nature of interactions between materials such as metals and salts, metals and acids, and oils and detergents
* make and explain inferences, predictions and conclusions using the data from investigations
* make generalisations about types of interactions – for example, oils float on water, acid-metal reactions generate hydrogen
* use genaralisations from patterns they have observed to make predictions about changes in simple interactions, and then design and perform experiments to test their predictions.

Providing students with these opportunities meant that the unit needed to involve a significant amount of laboratory-based work. When developing the practical activities, Teacher B considered the SLEI items that make up the Open-endedness

scale. She decided that students needed to develop some skills related to experimental design before their practical work could become particularly open-ended. She was also very conscious of workplace health and safety concerns and the need to put some constraints on experiments students design themselves.

In the initial component of the unit focussing on factors affecting the rate of a reaction, the teacher reviewed components of experimental design such as what constitutes a fair test and variable identification and control. The first few experiments students carried out required them to follow a recipe-style procedure and record their results in the table provided. However, significant discussion was facilitated relating to identifying the variables and how they were controlled, determining whether or not the experiment represented a fair test, and how the procedural steps of the experiment provided data relevant to the aim of the experiment. Students then started modifying procedures to improve the design of experiments and gradually started designing their own experiments to solve given problems. As students progressed through other components of the unit, they were provided with more opportunities to design experiments themselves. Different amounts of scaffolding were provided depending on the needs of individuals or small groups of students as well as the complexity of the problem students were asked to solve. All procedures had to be carefully checked by the teacher before students carried them out, with a particular emphasis on safety issues. Where modifications were necessary, the teacher assisted students by asking pertinent questions rather than by simply suggesting the necessary changes herself.

In relation to the Open-endedness scale of the SLEI, Teacher B felt that as a result of the way she had organised the unit, changes should occur that would make the actual laboratory learning environment closer to that preferred by students.

Teacher C, a male in his first year of teaching, was a physics specialist. He lacked confidence when teaching science units that were not physics related and so decided to address this by working with a class that was studying the same biology related unit as Teacher A's. In doing this he was able to work collaboratively with Teacher A, tapping into her biology expertise. This was only allowed to happen on the proviso that Teacher C did not rely on Teacher A to do all the work. Teacher C

needed to work very closely with Teacher A as they planned and developed their classroom environment improvement plans collaboratively. The information already provided about Teacher A's improvement plan is relevant to Teacher C.

Teacher D is a female teacher with four years teaching experience. She decided to develop a unit based on experimental design. This unit had the capacity to draw on aspects of biology, chemistry and physics. She decided to organise her class into groups of three students. She determined the groupings but sought input from the students by asking them to nominate two fellow students that they would like to work with and two students they would prefer not to work with. She was able to organise groups so that each student was in a group containing at least one of the peers they wanted to work with and no more than one of the students they did not want to work with. The teacher did not plan to keep the groups the same indefinitely but wanted them to remain intact while she addressed some basic teamwork skills. To do this Teacher D followed the cooperative learning guidelines provided in the Queensland years 1 – 10 science sourcebook guidelines (1999, p. 60). One aspect of these guidelines was the identification of team roles which students rotate through to develop different skills. The manager is responsible for collecting and returning equipment; the speaker seeks information from, and provides information to, other groups and the teacher when required, and shares any information obtained with all team members; and the director makes sure the group understands the task and how to complete it, helps the team focus on each step to be completed as well as offering encouragement and support.

The key components of the experimental design unit provided students with opportunities to:

* analyse investigations to decide whether or not they are fair tests
* design and perform investigations that incorporate the elements of a fair test
* identify and control variables in investigations
* judge the credibility of results.

With respect to the Leadership scale of the QTI, Teacher D decided to focus on the following behaviours – explain, organise, set tasks, determine procedure and structure the classroom situation. She felt that the unit lent itself to students working

in groups on a regular basis but that if this was to be successful she would need to exhibit these behaviours to provide students with the necessary structure and information to assist them develop collaborative learning skills.

The unit has been designed so that initially students carry out investigations where the procedure has been provided. Analysis of these procedures addresses the concept of fair tests as well as variable identification and control. At an appropriate time, some procedures are provided but need to be modified to ensure that they represent fair tests and that variables are controlled effectively. This provides students with some opportunities to start designing their own experiments. Later in the unit, students are required to design experiments in response to problems which need to be solved. Some choice is allowed so that groups can select topics which interest them.

In relation to the items that comprise the Open-endedness scale of the SLEI, this unit provides students with some opportunities to pursue their own interests by building in a degree of choice. The experimental design component requires groups of students to design their own experiments to solve a given problem. This means that different groups of students will collect different data for the same problem as well as doing different experiments. Early in the unit the teacher decides the best way for students to proceed when carrying out experiments but as the unit progresses students have more input into the procedures they follow.

Qualitative information obtained from students, teachers and the researcher which is pertinent the this phase of the study is reported in Chapter 5. However, at this point it is appropriate to note that as a result of feedback from the participating teachers the reassessment phase of the study was not conducted immediately after this period of intervention. This will be further discussed in Chapter 6.

4.6 SUMMARY

Data presented to participating teachers after students had responded to the Actual and Preferred Forms of the QTI and SLEI provided a very powerful starting point for the process implemented to bring about changes to classroom environments. It is very difficult to ignore data provided by your students about your classroom

practices. The participating teachers responded to the challenge of listening to what their students had to say, decided on a plan of action and implemented the plan. In doing this they moved outside their comfort zone and underwent significant professional growth.

CHAPTER 5

QUALITATIVE DATA

5.1 INTRODUCTION

In this chapter, qualitative data collected throughout the first four stages of this study are presented and analysed. These data come from participating students, teachers and the researcher. Details relating to the collection of qualitative data are provided in Chapter 3.

This chapter is structured around the first four steps of the five-step process on which this study is based. The qualitative data reported in this chapter come from field notes kept by the researcher as a record of observations made by her, comments made by students and teachers, as well as responses to questions she asked of students and teachers. Rather than setting up a formal process for collecting qualitative data, the researcher utilized well-established routines that she already had in place for interacting with students and teachers. The first section relates to the assessment phase of the study where students responded to Actual and Preferred Forms of the QTI and SLEI. The qualitative data collected in this phase have been grouped by each scale of the relevant instrument. The second section focuses on the feedback, and reflection and discussion phases of the study. The qualitative data reported and analysed in this section were obtained from participating teachers. The third section deals with the intervention phase. A summary concludes the chapter.

5.2 ASSESSMENT PHASE

In this phase of the study, in addition to their responses to the Actual and Preferred Forms of the QTI and SLEI, students were interviewed and their comments have

been grouped according to the scales of each of these instruments. Teacher comments and observations made during class visits are also reported.

5.2.1 QTI Related Qualitative Data

A description of each scale and sample items was provided in Table 2.2 while Table 4.5 provided the QTI scale means and standard deviations.

5.2.1.1 The Leadership Scale

Key teacher behaviours associated with the Leadership scale of the QTI are notice what's happening, lead, organize, give orders, set tasks, determine procedures, structure the classroom situation, explain and hold attention.

During class visits which occurred after students responded to the Actual and Preferred Forms of the QTI, the researcher asked some students questions relating to aspects of this scale. Initially, students were asked, "Do you think your science teacher is a good leader?" Depending on their response they were then asked either "What is it about your science teacher that makes you describe them as a good leader?" or "What is it about your science teacher that makes you say they are not a good leader?"

The following examples typify responses given by students who identified their science teacher to be a good leader. To maintain privacy, real names have not been used anywhere in this chapter.

Aaron: Miss always seems to be on top of things. If some people in the class are doing the wrong thing she can get them back on track really quickly.

Terri: I always know what I'm supposed to be doing in science and even if I finish early I know what I should do next because she puts like a list of things on the board at the start of each lesson so we can see what's going to happen. Some other teachers seem to make things up as they go along 'cos if you ask them what to do next they tell you to wait until everyone else has finished.

Jenny: Sir always seems to know what I'm doing even if he doesn't seem to be taking any notice if me. He gives me that look that tells me he knows I'm talking or writing notes or whatever. But what I really like is that he gives me a chance to start doing the right thing without yelling at me or anything like that. If I don't he'll come over and stand near me or start asking me questions about my work. He sort of tries to get me to do the right thing without having to tell me about it.

Warren: If we're being bad she doesn't rant and rave like some other teachers do but, I dunno, she seems to change what's happening in the lesson. You know, she gets us to do the same thing but in a different way.

Nadine: She lets us have a bit of fun in science but we've still got to do our work. She soon lets us know if we're mucking around too much.

John: He's real good at explaining things. My mum reckons he is too. Sometimes she gets me to ask him questions for her when she tries to help me with my homework and doesn't understand some things.

Amanda: Mr J – he seems to just know when you don't understand something and comes over to help. You don't have to feel silly for asking him to explain something again because he usually explains it again before you have to ask.

Justin: Sir tries to get to know us, you know, as real people not just school kids. When he talks to us he talks about things we like – footy and things like that. When he explains things he tries to relate it to things we're interested in.

Anne: She's fair. She doesn't pick on one person for doing something and then the next day let someone else get away with doing the same thing.

Students who did not classify their science teacher as a good leader made comments such as the following.

Sara: You never know how she's going to react. One day she'll yell at you for doing something and the next day she'll ignore it.

Mark: I have trouble understanding some of the things he tells us but when I ask for help he says the same thing again and I still don't understand.

Meg: He tries to be best friends with us, laughing and joking and talking like us. But that all changes when something goes wrong and he blames us.

Sam: Miss can't seem to control us. I think it's the way she treats us that gets my back up. When I do something wrong she gets really sarcastic and says things that I don't like. I end up being rude to her and getting into more trouble. I just don't respect her.

Tom: Sir doesn't seem to give us enough information. He just tells us to do something but doesn't tell us how to do it. When we ask he says we should know what to do. I know I don't always listen but sometimes I reckon why bother because I'm not going to hear anything useful anyway.

Sue: He keeps changing things. One day things'll go really good because he tells us how to do things but then he seems to get disorganized or something and leave it up to us how to do things. But if we don't do it the way he wanted us to do it we get into trouble.

Martin: Every lesson seems to be like joining a new class, there's no links between one lesson and the next. I seem to be lost all the time as there's no structure.

Jamie: He's all over the place. I reckon he works out what he's going to do as he walks to our room.

Karl: You should see some of the things the guys up the back do. Half the time they sneak out the door. He doesn't take any notice.

Jane: It depends who you are. Every time Sam does one little thing wrong she gets up him but John and Andrew muck up all the time and she just ignores it.

Even though teachers were not asked to respond to questionnaires as part of this study, they became familiar with then. Comments such as the following were made by teachers during discussions.

I've never really though about leadership in terms of how I interact with students in my classes. I've thought about it more in terms of my involvement in extra-curricular activities or other roles that I take on outside the classroom. The key teacher behaviours associated with the leadership scale of the QTI give me something to focus on in the classroom so that I can become a more effective leader.

In relation to the Leadership scale, key behaviours referred to by students include fairness, consistency, personal attention, continuity and knowing what's happening. These link quite well to the teacher interpersonal behaviour characterised by this scale, thus reinforcing the link between theory and practice.

5.2.1.2 The Helping/Friendly Scale

Teacher interpersonal behaviours which are characterised by this scale include assist, show interest, join, behave in a friendly or considerate manner, be able to make a joke and inspire confidence and trust.

During informal discussions with students, while assisting them with practical activities, the researcher sought responses to questions such as "What is it about your science teacher that makes you look forward to coming to science lessons?" and "When your science teacher talks to you in class, what sorts of things do they talk about?"

The following responses provide a cross-section of the comments made by different students:

- *I don't like coming to science lessons. I feel like Miss wants to pin me out on one of her dissecting boards like a specimen. I try and get her to lighten up by cracking jokes but she just glares at me.*

- *Sir always has something written on the board to catch our interest like some scientific term that starts with the same letter as the day. Today it's Food Web Friday and the other day it was Test Tube Tuesday. It's only a little thing but it makes me feel good.*

- *Sir always calls us by our name when he talks to us and he mentions things we've done. Like, when I got my photo in the paper at the campdraft he asked me about my horse. He makes you feel like he cares about you.*

- *Miss can take a joke but she lets you know when it's time for work.*

- *I don't like asking her questions if I don't understand something. She answers but I always feel as though she thinks I'm a real pain for asking.*

- *I was sick a few weeks ago and when I got back to school Miss asked me if I was better. I felt she cared about me.*

- *Sometimes you have things happening in your life and you just want to be left alone. This doesn't count with Miss, you've gotta be doing what she wants you to do all the time or she gets stuck into you. It's like you got no life outside her class.*

- *He coaches our footy team and in class he always seems to mention things that happened at training or in the game. If someone has a really good game he tells the class about it. When I scored my first try and he told everyone they all clapped and congratulated me. It was almost better than when I actually scored.*

- *I've been in her class for months now but sometimes she looks at me as though she's never seen me before. I don't think she knows my name – well she's never called me anything.*

Student comments relating to the Helping/Friendly scale highlighted a preference for teachers who make an effort to get to know their students and treat them as an individual who has a life outside the classroom.

5.2.1.3 The Strict Scale

This scale is characterised by teacher behaviours which keep the reins tight, check, judge, get the class silent and maintain the silence. Norms are exact, rules are set and enforced and the teacher is strict.

Discussions the researcher held with students elicited responses to the questions "Do you think your science teacher is strict?" and "Why do you think this?"

Responses included the following:
Sandra: She is so strict it's like being in prison. You've gotta do what she says no matter what.

Jerry: He's strict but not over the top. At least you know what's expected of you. His standards are really high. I like that because it makes me do better but some kids just give up.

Holly: Ya can't even talk. She's always yelling at me for talking and then I get in more trouble because I end up yelling back.

Mandy: Rules! There's a rule about every little thing – if you do this, this is what'll happen to you. I hate it.

Tom: The rules make it clear what you can and can't do but they're too restricting. There's no room for having fun.

Scott: It's chaos in his class. There don't seem to be any rules or if there are no-one obeys them. This is my worst class 'cause ya get away with doing nothing and then get really bad results.

Katie: She's so critical and really sarcastic when you ask something about one of her stupid rules. She needs to realise we're people too and have feelings. She puts you down all the time.

With respect to the Strict scale students appreciated knowing what was expected of them but did not respond well in situations where they perceived their teacher to be inflexible. Students appeared to want boundaries, but not immovable ones.

5.2.1.4 The Understanding Scale

Typical behaviours associated with this QTI scale include listen with interest, empathise, show confidence and understanding, accept apologies, look for ways to settle differences, be patient and be open to students.

Students who felt that their science teacher displayed these sorts of behaviours described them in the following ways:

- *Miss always seems to listen when you tell her something. She'll often come up to you a few days later and check how things are going.*

- *Miss and I had a big fight one day because I wasn't doing my work. She ended up sending me to the office because I was so rude to her. I'd just had an argument with my boyfriend and was really upset. When I went to apologise to her she was really nice and apologised to me as well. She said she should have realised something was wrong because I usually don't behave like I did that day.*

- *I'm real slow doing my work but Sir he sits and helps me and one day he writ in my book for me.*

- *When someone gets in trouble with Sir he tries to work it out with them.*

- *If you have a run in with Miss you can usually talk to her about it and ask her why she kept you in or whatever. She'll even listen to why if you don't agree with her and ask what you would have done.*

Students who felt that their science teacher did not display understanding behaviours made comments such as:

- *She just fobs you off if you try to talk to her and tells you to go and see someone else.*

- *I tried to apologise to her after I was rude to her one time and she just stared at me and said "Do as you're told next time." I'm not gonna pick her class again.*

- *He's only interested in what happens in his class. It doesn't matter that you've got a life and things happen there.*

- *She never lets go. Every time I get in trouble she brings up things that happened in the past. She's already dealt with them so why can't she just deal with what's just happened? I'm trying to do better but she just keeps dragging old stuff up.*

- *He's so impatient. Johnnie's really slow when he copies off the board and makes lots of mistakes but he keeps him in every time until he gets it right.*

The personal touch came through strongly in relation to the Understanding scale – knowing and treating students as individuals as well as talking through issues with them in order to solve problems.

5.2.1.5 The Uncertain Scale

Teacher behaviours associated with the Uncertain scale include keeping a low profile, apologising, waiting to see how the wind blows and admitting one is in the wrong.

When interacting with students in their science class the researcher asked students "Do you think your teacher feels confident when they are teaching your science class?" and "What makes you think this?"

Student responses included:

Allan: Sir's always pretty confident. At the start of the lesson he tells us what's going to happen and it usually does.

Joe: The tone of Sir's voice makes you feel that he knows what he's doing. Sometimes he gives us a choice but he tells us what we can choose from.

Susie: Miss is hopeless when we muck up. She waves her hands around and pleads with us to stop but most of the class just ignores her.

Jane: Miss doesn't seem to be able to take control of the class. There's a few people like Robert and John and Chloe who almost take over. If Miss says we're going to do something they can talk her out of it.

Maria: Miss is really quiet but she just gets on with being our teacher. She really knows what she's talking about.

Sandy: Sir is so laid back but if we try him out he soon pulls us back into line but in a way that doesn't cause big problems.

Julie: Miss is sometimes confident but at other times it's like she's not sure about what she's teaching us. Anything to do with biology she seems to know about but if it's chemistry or physics stuff then she sometimes has to look up her notes a lot.

Trent: Sometimes we ask her hard questions just to see her go red in the face and stutter and stumble because she doesn't know the answer. I know that's mean but why can't she just say she doesn't know. We'd respect her more if she did that.

When considering the Uncertain scale students seemed to prefer teachers who just got on with their job and kept them informed.

5.2.1.6 The Admonishing Scale

Admonishing behaviours exhibited by teachers include getting angry, taking students to task, expressing irritation and anger, forbidding, correcting and punishing.

When students were asked how their science teacher responds when they do something he or she is not happy about, they provided answers such as:

- *Sometimes she gets really angry but usually she asks you what you should be doing and tries to get you back on track.*

- *She just goes right off and gives you detention. She doesn't try and find out why you did it, just assumes you were deliberately being bad.*

- *He growls a lot.*

- *She tries to get you to do the right thing by yourself rather than pull you up every time you step out of line. She'll just look at you in a certain way or come and stand near you or say your name. If you don't get the message then she'll take things further.*

- *Miss is pretty good. She'll usually try to get you doing what she wants without saying much. If you don't stop what you're doing and get on with your work she usually comes and sits down and starts asking questions about your work to get you back on track.*

- *Sometimes she loses it and starts yelling as soon as someone does one little thing wrong. I think this happens when she's had a bad class before us. These lessons are really bad and we usually don't get any work done because she spends her time yelling and putting people on detention or sending them to the office and everyone ends up in a bad mood.*

- *Sir can be sarcastic but only with a few people. When he gets angry he says his bit and then gets on with it. You always know where you stand with him.*

- *When Miss yells you know you've gone too far. She doesn't do it much but when she does you know you need to do something or there'll be trouble.*

In relation to the Admonishing scale students preferred teachers who tried to get them to take responsibility for their actions rather than exhibiting behaviours associated with negative actions.

5.2.1.7 The Student Responsibility Scale

Teacher behaviour typical of this scale is to provide students with opportunities for independent work, wait for the class to let off steam and give freedom and responsibility to students.

The researcher obtained comments such as the following as feedback from science students in response to the questions "What sort of input do you have into how your science class functions?" and "Are all members of your science class expected to do the same work?"

Jim: Our teacher sometimes gives us a choice of what activity we'll do in the next lesson. Once we've decided the whole class does the same thing.

Cameron: Miss always decides what we're going to do each lesson but we're good at convincing her that we're too tired to do much on Friday afternoons.

Mary: When we go to the library to do research we always have a choice of topics. We can select a topic which interests us and we're not all tying to get the same books.

Jill: When we do experiments we sometimes get to choose which ones we'll do – there might be three set up and we have to do two.

Amber: Occasionally Miss sets up stations 'round the lab and we get to move from one to the next. I like that but by the end we've all done the same things.

Dean: I don't know why they're called experiments 'cos all we do is follow a series of steps. It's "do this" then "do this" and "write down what you saw." I'd like to try some "what if" experiments.

The key behaviour students associated with a teacher who gave them responsibility and freedom was choice.

5.2.1.8 The Dissatisfied Scale

Key teacher behaviours associated with this scale include waiting for silence, considering pros and cons, keeping quiet, showing dissatisfaction/looking glum, questioning and criticising.

When working in science classes the researcher questioned students about the frequency and type of positive feedback they received from their teacher about their behaviour or work. Responses included:

- *Whenever we start a new topic Sir starts right from the beginning as though we don't know anything at all. It gets really boring sometimes.*

- *How many times a lesson does she say "I'm not going on until the room is silent"? Then she gets that look on her face and someone giggles so she goes ballistic.*

- *I'm glad I'm not married to her. She nags all the time and finds something wrong with everything we do.*

- *Miss gets up you if you do the wrong thing but she also lets you know if you do well which makes you feel good.*

- *I think Sir only likes teaching the seniors. He hardly lets us touch any equipment in case we break it.*

- *You listen when she talks to us about an experiment. It's always "don't do this, don't do that". She doesn't trust us.*

- *Miss gives out stickers when we work hard.*

- *He never seems happy with what we do, except for his pets who suck up to him all the time.*

- *She sent a letter home after I did really well on my test. Mum and Dad liked that.*

When students perceive teachers to be dissatisfied with their actions they feel that they are constantly finding fault with what they are doing, thus creating a negative classroom environment.

5.2.1.9 Comments on the Qualitative Data

The quantitative data reported in Chapter 4 provided an overall picture of how the students perceived certain aspects of the interpersonal behaviour exhibited by their science teachers. What the data did not provide was any insight into what it was about their teachers' behaviour that prompted them to respond to the questionnaire items in the way that they did. The qualitative data obtained from students do provide some background information. This is particularly important in this study because teachers are going to attempt to change one or more aspects of their behaviour so that their classrooms better resemble an environment preferred by students.

Information obtained from students provided a broad spectrum of perspectives but key messages about desirable teacher interpersonal behaviours were evident for each scale of the QTI.

5.2.2 Qualitative Data relating to the SLEI Scales

A description of each of the five scales was provided in Table 2.6. Table 4.6 summarised the SLEI scale means and standard deviations.

As previously indicated the researcher, in her role as Head of Department, was a regular visitor to science classes. Teachers and students were used to her assisting and interacting with them during science lessons. The qualitative data presented here were collected during her visits to laboratory-based lessons as she talked to, and observed, students.

5.2.2.1 The Student Cohesiveness Scale

Feedback from students about their perceptions of the extent to which group members help and support each other during practical work included responses such as:

- *Every time we do an experiment Sir puts us in different groups so we don't get much of a chance to get used to working with each other. Sometimes one or two people take over and the rest just fool around. It depends whether you (the researcher) or Miss Lunn (the laboratory assistant) works with a group. They seem to work better then.*

- *When we're gonna do a prac, Miss says "right, get in groups of four". Some groups end up working really good but others don't. 'Specially those made up of the leftovers that Miss has to organise.*

- *We work in the same prac groups for a whole term and Miss gives us job cards each time. One lesson I might be the recorder and then I might be the cleaner upper or the one who gives directions. Everyone gets a turn at doing different jobs. If someone doesn't do their job properly the others in the group try to help them. It's pretty good 'cause you get to know what other kids are good at and you can get them to help you if you aren't good at something you've got to do.*

- *We work in the same groups all the time. My group is okay as we help each other but some groups are hopeless and get sent to sit down away from the benches a lot. Mrs Lunn sometimes comes to help with them or Sir has to stay at their bench a lot.*

As can be seen from the comments made by students, qualitative data provide specific information which is not generally available if only quantitative data are collected. This allows for a more detailed understanding of what students perceive about the classroom environment.

5.2.2.2 The Open-endedness Scale

The following comments were made by students in relation to the extent to which their laboratory activities were open-ended and/or divergent.

Samantha: Doing pracs is a bit like following a recipe in Home Ec. Everyone is supposed to follow the same procedure and end up with the same results.

Thomas: It's good when Sir sets stations up around the room and we get to do different experiments. But by the end we've still all done the same experiments.

Jerry: I like it when we do experimental design. Miss gives us an equipment list and a question. We have to design and do an experiment to come up with an answer to the question. We don't get to do this very often but it's good.

Ellen: Most times when we do experiments you know what the results should be. Sometimes we get to investigate "what ifs" where our group gets a chance to see what happens if we change something about the experiment. I think we'd learn a lot more if we got to do this more often.

Tanya: Last year we got to design some experiments ourselves but this year we just get procedures to follow. It's really boring.

Rod: When we did the unit about forces and motion we got to design some experiments ourselves and learnt about variables and fair tests. But now that we're doing biology we just get to follow procedures. I don't think Sir knows as much about biology as he does about physics so that might be why.

Information provided by students clearly supports the quantitative data in that they definitely prefer more open-ended practical activities. Students are very perceptive and can pick up on the strengths and weaknesses of teachers quite rapidly.

5.2.2.3 The Integration Scale

Students were asked how closely practical activities related to the rest of the work they did in their science classes. A cross-section of responses appear below:

- *Most prac work is related to what we do in theory lessons. We either learn about the theory and then do a prac that backs up the theory or do a prac and use the results the next lesson when Sir goes through the theory.*

- *It's good when we learn something in science and then do a prac where the results fit in with what we learnt. Sometimes the pracs don't work very well.*

- *Sometimes we seem to do pracs that have nothing to do with the topic we've been studying. I don't mind because I like doing prac work.*

- *Some topics don't have much prac work in them but usually the pracs and the theory fit together.*

- *Usually Miss talks about prac results when we're doing theory and links them together but sometimes we just seem to do a prac because we're in the lab.*

- *Mostly prac work relates to the topic we're doing.*

Students generally indicated that practical work was linked to the theory components of their science courses.

5.2.2.4 The Rule Clarity Scale

Student comments outlined below were made during discussion about their awareness of the expectations of their science teacher during practical work.

Robbie: The posters on the walls in the labs state the main laboratory rules and Sir always goes through particular safety rules at the start of each prac.

James: From the very first lesson in a lab everyone is made aware of the safety rules. There are posters around the room and we go through why the rules are important. Most teachers are fairly strict and if you don't follow the rules you don't get to do prac work.

Scott: Most teachers expect you to follow the rules and if you don't you're not allowed to do pracs. The rules are pretty basic but I hate wearing safety glasses.

Amy: The rules are on the walls in all the labs and mostly teachers expect you to follow them when you do prac work. A few classes run amuck but mostly thing are okay.

Helen: Miss usually goes through the safety rules before we start an experiment. If anyone is being silly during an experiment she makes them sit down at the front of the room so they don't get to do the experiment.

Wendy: If you don't have the right footwear on, you don't get to stay in the lab if the class is going to do a prac.

Information provided by students indicated that laboratory rules were quite clear and reinforced by most teachers in a consistent manner.

5.2.2.5 The Material Environment Scale

The following comments were made by students during discussions about whether or not laboratory equipment and available resources were adequate.

- *Most of the time we do pretty basic experiments which don't need much equipment so there's no problem.*

- *The labs are really old – they were here when my Dad went to school. The benches are really uncomfortable to sit at.*

- *We need more labs so that we can have all our science lessons in them and not have to share with other classes.*

- *The beakers and test tubes and that sort of thing are okay but we need more digital balances. Miss told us they're really expensive so we can't afford to buy many.*

- *We don't have much computer equipment to use in science. When we use computers to do prac work only a few of us get to do it at a time.*

- *Some more microscopes would be good 'cause there's only enough for one per group. One each or one between two people would be good.*

- *The lab benches are gross – all scribbled and written on and so are the stools but the beakers and bunsens and that sort of thing are okay. We don't have lots but there's enough to go 'round.*

- *We got to use the new electric circuits kits a while back. They were great and our pracs worked. Each group had a special box themselves and didn't have to share.*

- *Some of the physics equipment is pretty old but gradually we're getting new stuff. Sometimes we can't do the experiment Sir wants us to until another class has done it because we don't have enough equipment.*

- *If we get to design our own experiments we have to be careful what we want to use in case we don't have it. Mrs Lunn is pretty good at borrowing so it's not too bad.*

As can be seen from the above comments, students have concerns with particular aspects of the material environment but overall they are quite satisfied with the equipment available.

5.2.2.6 Comments on the Qualitative Data

The quantitative data relating to each scale of the SLEI which was reported in Chapter 4 showed that while the difference between the actual and preferred item mean for each scale was statistically significant they were relatively small for all but the Open-endedness scale.

When considering qualitative data obtained from students it was obvious that individual students had varied opinions in relation to characteristics of the laboratory environment such as the structure and function of groups, the open-endedness of practical activities, the links between practical and theory aspects of science units, laboratory rules and the adequacy of laboratory equipment and resources. However, considering the range of comments made in relation to each SLEI scale it appears as though the qualitative data reflect the quantitative findings.

5.3 FEEDBACK AND REFLECTION AND DISCUSSION PHASES

Qualitative data reported in this section of the chapter were obtained during the Feedback and Reflection and Discussion Phases of the study through discussions between the researcher and participating teachers, either individually or in a group. The two phases have been dealt with together because these discussions did not necessarily relate to just one of the phases.

Prior to the collection of qualitative data from participating teachers, each had been provided with a package of information as described at the end of Section 4.3.2. This meant that, as well as being familiar with the classroom environment instruments used to collect data, they were aware of the information provided from the analysis of the data.

TEACHER A: *I found the process and resulting data quite fascinating. To actually obtain this type of feedback from my students and then respond to it in an attempt to change some aspects of my teaching practices provided a real challenge. As an inexperienced teacher, I know that I have a long way to go to become the teacher I would like to be but having data provided by my own students in relation to both*

actual and preferred teacher behaviours gives me a staring point for my own professional growth. I can assume control of some aspects of that growth because my students have told me where I currently am as well as where they would prefer me to be. I've got to work out how I can move closer to where they would prefer me to be.

I was a bit apprehensive about what the data would show. What if the actual perceptions of my students were very different from the actual perceptions of the students of the other participating teachers? What if there were large differences between the actual and preferred perceptions of my students in areas where I thought I was performing well?

The data that were of most interest to me were those that my classes had provided in relation to me. I guess my first thought when seeing the graphs was one of relief because the data from my classes didn't stand out as being very different from that of other teachers' classes. I was a bit taken aback to note that I'd scored worse than anyone else on the Helping/Friendly scale of the QTI. The data relating to the Uncertain scale of the QTI surprised me as I felt that, due to my inexperience, I came across as quite uncertain at times. It seems as though the students prefer that – maybe it boosts their confidence to know that we don't know all the answers so it's okay that they don't.

Even though we used a team approach to determine which aspects of our classroom and laboratory environments we were going to target for change, the process is one that I could quite easily use on an individual basis at a later stage.

Targeting the Open-endedness scale of the SLEI for bringing about changes to the laboratory environment was an obvious choice based on the analysis of the data. After lots of discussion about which QTI scale to target, we were having difficulty agreeing so we started narrowing down the options by ruling out scales. Initially, we ruled out the Uncertain, Dissatisfied, Admonishing and Strict scales as these had the smallest actual/preferred differences based on the overall data. From there, each of us identified the scale we would be most interested in targeting and the scale

we were least interested in targeting . The Leadership scale came up trumps and our decision was made.

TEACHER C: *I was very reluctant to participate in this study when the idea was first raised. As a first year teacher I felt that I was struggling to cope and that this would be an added burden and that my students would provide data that highlighted my inefficiencies. My specialist teaching area was physics and, as there was not a lot of physics in the science that I was teaching, I felt a bit out of my depth. The enthusiasm of my colleagues and their support and encouragement gave me the courage to take part in the study, even though I was still rather apprehensive. I was really pleased that someone else administered the questionnaires.*

I was quite chuffed when I saw the graphs of the data from the questionnaires. In terms of the actual perceptions of my students I was in there with my colleagues, not standing out by myself as I feared. In fact, on some of the QTI scales, such as Strict and Admonishing, my behaviours were closer to those preferred by the students than anyone else's.

Looking at the graphs of the SLEI data in comparison to those showing the QTI data, regardless of what sub-groups were being represented, the actual perceptions of students were very similar. This seems to indicate that the way we structured our practical activities was pretty standard but that there were more differences in the ways we interacted with our students. One thing that I picked up on for further thought was that male students perceived greater differences between actual and preferred teacher behaviours than did female students on QTI scales such as Helping/Friendly, Understanding, Dissatisfied, Admonishing and Strict.

When we were trying to decide what scale of each instrument to target to make changes to our classroom practices, the SLEI choice was easy. The largest difference between our students' actual and preferred laboratory environments was in the Open-endedness scale and we all agreed that it was a worthwhile area to change. The decision about which QTI scale to target was a bit more complex and lots of discussion occurred. For me, the largest differences between actual and preferred data occurred on the Helping/Friendly, Understanding, Student

Responsibility and Leadership scales. For the other teachers the Helping/Friendly, Understanding and Student Responsibility scales all had higher actual preferred differences than most of the other scales. How then did we decide on targeting behaviours associated with the Leadership scale? I think we looked very closely at the behaviours associated with each QTI scale and decided that some of those associated with the Leadership scale encompassed some of those associated with the other scales and so were big-picture behaviours for us to target for change.

Ultimately, we decided to target the Leadership scale from the QTI and then started work on the development of our classroom environment improvement plan.

TEACHER D: *Participation in this study is shaping up to be the most relevant professional development activity I have been involved in since becoming a teacher. While I'm not big on questionnaires, the QTI and SLEI were not just developed for use in this study and so had a large amount of credibility associated with their use and the reliability and validity of the resulting data. The focus was on me as a teacher and my students.*

When looking at the graphs of the data I felt quite excited – here was something concrete for me to work with. It gave me a snapshot of some aspects of my classroom practices from the perspective of my students. I could use this information to target specific areas for change, work to bring about desired changes to my classroom practices and then take another snapshot to see whether or not I had been successful. Once I'd seen the graphs, I couldn't wait to get on with the next phase of the study. The SLEI data fascinated me – that regardless of the teacher or the gender, year level or result of the student there was very little difference in their perception of the actual laboratory environment for any scale. Given that students were using the same laboratories and that within each year level the same units were being studied it doesn't really surprise me that the laboratory environments are similar. The fact that the students picked up on this just blew me away. It probably shouldn't have, as I know that students are amazingly intuitive, but it did.

The decision to target teacher behaviours associated with the Leadership scale of the QTI for change was nowhere near as clear cut as our decision to target the Open-

endedness scale of the SLEI. We almost decided not to all target the same scale because we were finding it difficult to agree on which scale but, ultimately, it was our desire to work together and support each other that influenced our decision.

When I looked at the QTI data, the Helping/Friendly scale was the one where there was the largest actual/preferred difference identified by our students. My initial reaction was that it made sense to target the behaviours associated with this scale as ones to change but when I looked more closely at the behaviours I had reservations. It wasn't that I didn't think the behaviours weren't important ones for teachers to display, more that they weren't behaviours I wanted to target. I then looked at the behaviours associated with the other QTI scales and felt that in targeting the Open-endedness scale of the SLEI we were actually dealing with some of those associated with the Student Responsibility scale. The behaviours associated with the Leadership scale clicked with me. I felt that my classroom practices would benefit from attempting to change some of these behaviours. Our final decision was to target this scale so I was pleased about that.

TEACHER B (the researcher): When I first suggested to the science teachers that I would like to conduct a research project and sought their participation, I was unsure what their individual responses might be. Involvement meant exposing their classroom practices, through the eyes of their students, to their colleagues. For some people this is very daunting. I think the fact that I was willing to be a participant, rather than simply the researcher, was significant. I also think that because I spent a considerable amount of time in their science classes on a regular basis they knew that I was already aware of their strengths and weaknesses.

Once the data had been collected, collated and shared with the participating teachers they seemed to breathe a sigh of relief and were very keen to discuss the implications of the data and prepare for the intervention phase of the study.

The other three participating teachers were all located in the same staffroom along with four other maths/science teachers who did not have any junior science classes, when the study was carried out. Having an office of my own, I was not based in this staffroom but spent quite a bit of time in there. Not too much had been said about

the study until the feedback phase was entered. Once the participating teachers had access to the data, particularly the graphs depicted in Figures 4.2 to 4.11, most conversations in the staffroom seemed to relate to the implications of the data. Even those teachers not involved in the study became part of the discussions. The quality and extent of the professional discourse which took place was incredible. While I took part in many of the discussions and made suggestions and responded to questions, I was more than happy for them to continue when I wasn't around. I wanted the final decision about what scale from each instrument was going to be targeted in order to bring about changes to classroom environments to come from the group of participating teachers rather than from me. Even though I was conducting the study it wasn't about me, it was designed to benefit the participating teachers and their students.

As indicated by the teachers, identifying which SLEI scale to target was straightforward but a lot more discussion was required before a decision was made about which QTI scale to target. At certain points during these discussions, decisions had to be made and it was at these times that I put my researcher's hat on rather than my participant's hat. The key decisions were:

- Are we all going to target the same number of QTI scales?
- How many QTI scales are we going to target?
- Are we all going to target the same QTI scale/s?

When the decisions needed to be made, I posed questions for the others to ponder. These questions focused on being realistic in terms of workload and what they wanted to achieve as a result of having participated in the study. Ultimately, the decisions resulted in targeting one QTI scale – the Leadership scale.

My prime reason for instigating the study was to improve student outcomes through changes to teacher interpersonal behaviours and aspects of the laboratory environment. Listening to discussions between, and participating in discussions with, the other teachers gave me an insight into what participation in the study meant to them. In general, their focus changed from being involved in a one-off, relatively short-term project where they attempted to change some aspects of their teaching in order to improve the outcomes of their students to being in a position to develop their

own ongoing project using data they collect to inform their continued professional growth in a practical way.

5.4 INTERVENTION PHASE

As previously discussed in Section 4.5, each of the four participating teachers developed and implemented a classroom environment improvement plan in this phase of the study. Details of these plans were provided in Section 4.5.1.

Qualitative data presented in the current section of Chapter 5 were obtained during discussions that occurred between the researcher and each of the other participating teachers while they were developing and implementing their plan.

TEACHER A

In preparation for developing her classroom environment improvement plan, this teacher considered the targeted QTI and SLEI scales. She made the following comments during discussions with the researcher:

- *In relation to the Leadership scale of the QTI I think it would be worthwhile for me to be more aware of what is happening in my classroom and to be more effective in holding the attention of my students. I don't want to try and change too many things at once but I could work on these two areas in conjunction with trying to make laboratory activities more open-ended.*
- *When I looked at the actual QTI and SLEI items that made up the Leadership and Open-endedness scales the key things seemed to be showing enthusiasm, clear explanations, holding attention, acting confidently, knowing what happens in the classroom and providing choice and experimental design opportunities in practical activities. My improvement plan will focus on as many of these as possible.*

The following comments were made by Teacher A as she developed and implemented her improvement plan:

- *When I started to formulate my improvement plan I thought about what I could do to change the things I had decided on but not go overboard and attempt to do things that I couldn't sustain. Since we had each decided to target only one class*

I decided not to pick my best or worst and negotiated to work on a biology unit as that was the area I felt most comfortable teaching. When Dan (Teacher C) expressed an interest in working with one of us on a biology unit I offered to work with him. Maybe later we can work together on a physics unit as that's his specialist area. Even though it created more work organising meetings, it kept me on track and we were able to share the location and preparation of resources as well as bounce ideas off each other. Because our classes were on at different times we were able to organise to work in each other's class on a few occasions. I was able to be with Dan for a couple of lessons where he still felt a bit uncomfortable with the topic and could chip in with comments and explanations. It also allowed us to see each other in operation in the classroom and get ideas from each other as well as provide feedback. This really helped in relation to increasing our awareness of what was happening in the classroom.

- *Even though this unit didn't really lend itself to experimental design activities we incorporated a wider variety of hands-on activities than either of us normally access and were able to provide some degree of choice in which activities students completed.*

At the end of the unit, once the improvement plan had been implemented, Teacher A made the following comments:

- *I feel as though I've just touched the tip of the iceberg. I think it's too soon to readminister the classroom environment instruments. Before that happens I'd like the chance to target other aspects of my behaviour and the laboratory environment, as well as leadership and open-endedness, with my other science classes.*
- *Tracey (Teacher D) is so enthusiastic about what she's been doing with her groups and experimental design that I'd like to do something in that area as I really haven't made too many changes to the practical components of my lessons yet. I'd also like to work with Dan on a physics unit.*
- *I think some of the other teachers in the staffroom are starting to feel a bit envious of what we're doing. There used to be a lot of negative conversations but while we still have disasters the positive and exciting conversations outweigh the negatives. The project has really brought us together as a team and because*

we know what's happening we can help each other a lot more. We seem more willing and confident to make suggestions to each other.

TEACHER C

As a first year teacher with a background in physics, this teacher lacked confidence teaching non-physics units of work in science. The following comments were made by him in the lead-up to developing his classroom environment improvement plan.

- *I never realised the implications of physics being the only science subject I studied during my tertiary studies. I can see that I'm likely to teach some science throughout my career so I need to do something about the areas of science that I don't have much background in. Biology is the worst area for me so I guess tackling it first would be a good idea. Because of my lack of knowledge and confidence in this area I think I'd benefit from working with someone else. Maybe we could teach the same unit and work together on the planning. At the moment I'm never sure whether what I've planned to teach is what I should be teaching so I tend to ask for a lot of help. I need to talk to the others and see what's possible. Our discussions over the last few weeks have resulted in some very positive professional relationships. Before that I wouldn't have felt comfortable having this sort of discussion with my peers.*

Teacher A offered to work collaboratively with Teacher C on the development and implementation of their improvement plan. He made the following comments in relation to this:

- *Just sitting down with Sharon (Teacher A) and talking about what we could do to come across to students enthusiastically and confidently, hold their attention, be more aware of what happens in the classroom and provide more choice was an eye-opener for me. How simple is preparing a series of cards, each with an interesting story related to the topic, that you can access at strategic times during a lesson? It worked so well but was something that I'd never thought of. Some of the kids even started brining things they found to class to share. When you're working with someone else it seems easier to come up with different ideas and activities. I would never have taken my class on an excursion but taking our classes together worked really well as she could answer the questions I would*

have had no idea about. I learnt something along with my students. It was also amazing what some of them knew, just from their experiences in the area.

- *Even though Sharon was the expert, I was able to contribute to our improvement plan. Sometimes it meant her doing the groundwork and collecting suitable resource material and then me doing something with it like modifying it to cater for students with different learning styles. I also developed some materials for use with a computer simulation that we had which made it easier for students to collect data from. Working in each other's class a few times was great. Sometimes I went to see how she did something with her class before I tried it with mine.*

Once the improvement plan had been implemented, Teacher C made the following comments:

- *Even after such a short time I feel as though I am a better teacher. Before I was swamped because I felt the need to improve in so many areas that I just couldn't seem to do it. Just working with one class and targeting some specific aspects of my teaching has had some flow-on effects in my other classes and I don't feel the need to try and fix everything at once.*
- *I'd like to be able to develop and implement some more improvement plans before the QTI and SLEI are administered again. At least one unit with each of my science classes would be good but I'd also like to be able to target some of the other QTI and SLEI scales. I now see this as a long term project.*

TEACHER D

This teacher made the following comments to the researcher when she was preparing to develop her classroom environment improvement plan:

- *I really want to focus on the practical work that my class does. I think that by making changes in that area I can also improve some of the behaviours associated with the QTI Leadership scale. I've already done some reading and have some ideas to work on so I'm keen to get going.*
- *I've always used groups for practical work but usually just put my students into groups or let them select their own groups and then expected them to get on with the activity. I've assumed they already had the skills required to work as part of a group. I guess if they've just got to follow a series of steps to carry out an*

experiment it doesn't matter too much but if they've got to design their own experiments and then do them they need to be able to work together. Teaching group work skills and giving students time to practice them needs to be part of my improvement plan.

- *I've taught students about experimental design before – fair tests, variables, things like that but it's never been the major focus of a unit. It's been quite disjointed, only happening here and there as part of other units where it fitted in.*

The following comments were made by Teacher D as she developed and implemented her classroom environment improvement plan:

- *Once I started looking there was a lot of material around which focused on working collaboratively in groups. I decided to work with groups of three students as this was what the support material recommended. Previously I tended to have four or five students in a group. Each member of the group had a specific role – manager, speaker and director. Once I had set up the groups I kept them the same for the duration of the unit but rotated the members of each group through each role so that in the future when they might be in different groups they could take on any role. It was really challenging to get some students to carry out one role – some wanted to take over and assume all the roles at once while others tended to take on no role at all or change from role to role whenever they felt like it. I ended up making name tags for each role so that I could keep track of who was carrying out each role in a group. This made it easier for me to support them in their assigned role.*
- *I don't like reinventing the wheel so I searched widely for practical tasks that I could use or modify for use in this unit of work. In doing this I really got to know what resources were available in the school and also found a lot of relevant material through the Internet. Along the way I collected a lot of resources for use in other units. I put a huge amount of time into preparing resources for use in this unit but thoroughly enjoyed doing it.*

Once the improvement plan had been implemented Teacher D made the following comments:

- *I feel that I have developed and taught a unit that is a must-do for every science student. I was so excited about the way my class got involved in the experimental*

design component that I kept dragging other teachers into the room to watch them at work. Different groups were working at different levels but everyone was engaged and interacting with other members of their group. I've never seen anything like it.

- *In future I wouldn't necessarily do the team work skills development and the experimental design as part of the same unit but the experimental design component wouldn't have worked as well if the students had not already had the team work skills.*
- *Being able to have the laboratory assistant and a teacher aide in the class made things a lot easier as we were able to work with specific groups. This was particularly useful when different groups were doing different experiments.*
- *Even though I focussed on the Open-endedness scale of the SLEI rather than the Leadership scale of the QTI, the things that were happening in the class actually addressed some of the behaviours associated with the Leadership scale. The students' attention was better focused where I wanted it – on what they were doing. The classroom environment was structured to promote involvement – not structured in such a way that everyone did the same thing at the same time but in a way that encouraged each group to get on with their activity. Because different groups were carrying out quite different activities at times I had to be versatile in my responses to their needs. This is why having other adults in the room was so beneficial. I think my preparation and planning changed because I focused on how I was going to do things as well as what I was going to do whereas in the past I focused predominantly on what I was going to do rather than on how I was going to do it.*
- *I'm not ready to move into the reassessment stage of the study yet. I want to spend more time in the intervention stage working with other classes, other units and other behaviours.*

TEACHER B (the researcher)

During the feedback and reflection and discussion phases of the study the participating teachers had expressed some fears relating to what the data might say about their classroom performance. They were all quite relieved when no individual stood out as being perceived markedly different to any other and went on to engage

in significant professional dialogue which forged bonds that allowed them to work together in the intervention phase of the study.

One of the strongest impressions I got from discussions I had with the other participants as they thought about their classroom environment improvement plans was that having access to data provided by their students was a significant contributor to their enthusiasm for, and determination to, bring about changes to their classroom practices. This was certainly the case for me. I had something concrete to work with. I was able to use the data to determine which aspects of my classroom performance I wanted to change and then plan for the desired change.

In relation to my own experiences when developing and implementing my classroom environment improvement plan, the following comments are significant:

- *In the past I've tended to avoid giving students opportunities to design their own experiments, due to safety concerns related to working with chemicals. I overcame this by focusing on everyday substances rather than chemicals as such. Doing this also allowed students to utilise their knowledge gained through their use of some of the substances on a regular basis.*
- *Given that my students had not done a lot of experimental design work I presented them with a series of problems that needed to be solved so that they had a starting point for their designs. Each group had to solve two problems so they had a fair amount of choice.*
- *After seeing what Tracey (Teacher D) did in terms of developing team work skills with her class, I think greater initial focus in that area would have helped my students. I also think her approach to fair tests and controlling and identifying variables would have provided useful background knowledge and skills for my students as they designed their own experiments.*
- *Even though some groups found that the experiments they designed did not necessarily allow them to solve their problem, they were prepared to make some changes and try again. They were in fact operating like scientists and this was very exciting for me as a teacher. Overall, I felt that every student achieved some degree of success in what they did and that this had a positive effect on their attitude to science.*

- *I've got lots of ideas that I want to pursue with my classes. It doesn't matter how experienced you are, you can always improve your classroom performance.*

5.5 SUMMARY

The collection and analysis of qualitative data has added a personal element to the study. Quantitative data are very powerful but while they are obtained from individuals the analysis relates to the whole sample or subsets of the whole sample and the individual input of the participants is masked.

The language used in the classroom environment instruments and hence the language of the quantitative data, is not necessarily that of the participating students and teachers. However, the language of the qualitative data is that of the participants as they have provided the information themselves without having to convert their language to that used in the questionnaires. In a study like this one, which is very much about the participants, it is important that their messages are received and acted on. By utilising both qualitative and quantitative data the chance of this happening is enhanced.

The quantitative data provided a valuable starting point for discussions between the participating teachers while the qualitative data kept them focused on their classroom practices and students.

The original plan had been to carry out the reassessment phase relatively soon after the classroom environment improvement plans had been implemented. As this time approached, the participating teachers made it very clear that they did not want this to happen until they had opportunities to develop and implement other improvement plans with different classes and, possibly, even targeting different teacher interpersonal behaviours and other aspects of their laboratory environments. Because of the enthusiasm of the participating teachers and the positive changes that already seemed to be occurring in classrooms, I was more than happy to delay moving on to the reassessment phase. In hindsight, I believe that too much time elapsed before the reassessment phase occurred. This will be discussed in Chapter 6.

CHAPTER 6

REASSESSMENT PHASE

6.1 INTRODUCTION

As detailed in Chapter 3, this study is based on a five-step process. Qualitative and quantitative data related to the first four steps in the process have been presented and analysed in the previous two chapters. This chapter reports on the final step in the process – the reassessment phase.

Sections 6.2, 6.3 and 6.4 report on the reliability and validity of the instruments used for data collection purposes in this stage of the study. In Section 6.5 pre-intervention and post-intervention data collected using the QTI and SLEI are compared. These comparisons were used to determine which, if any, aspects of the learning environment students' perceived to have changed after the learning environment improvement plans had been implemented. Section 6.6 focuses on identifying associations between classroom environments and students' attitudinal and cognitive outcomes. A summary concludes the chapter.

6.2 RELIABILITY AND VALIDITY OF THE QTI

Background information relating to what constitutes a quality multi-scale classroom environment research instrument has previously been discussed in Section 4.2.1. Tables 6.1 and 6.2 report the reliability and validity statistics for the 48-item Australian Form of the QTI used with the target sample of 217 students in 13 science classes in the reassessment phase of the study. Due to the sample size, analyses were carried out using only the individual student as the unit of analysis.

Scale internal consistencies were confirmed by the calculation of Cronbach (1951) alpha coefficients for each scale. Table 6.1 reveals that the alpha reliability figures for different scales in the Actual Form of the QTI range from 0.64 to 0.89. These

figures are all above the threshold value of 0.6 which Nunnally (1967) identified as an indicator of acceptable reliability for research purposes.

Table 6.1

Internal Consistency (Cronbach Alpha Coefficient) and Ability to Differentiate Between Classrooms for the Actual Form of the QTI

Scale	Alpha Reliability	ANOVA Results (eta^2)
Leadership (Lea)	0.86	0.30 ***
Helping/Friendly (HFr)	0.89	0.41 ***
Understanding (Und)	0.87	0.33 ***
Student Responsibility (SRe)	0.68	0.19 ***
Uncertain (Unc)	0.74	0.14 **
Dissatisfied (Dis)	0.81	0.19 ***
Admonishing (Adm)	0.78	0.32 ***
Strict (Str)	0.64	0.30 ***

** $p < 0.01$ *** $p < 0.001$ N = 217

Another characteristic of the QTI that was investigated in this study was the ability of each scale to differentiate between the perceptions of students in different classrooms. This was determined using the one-way ANOVA eta^2 statistic for each scale, with class membership as the main effect. As shown in the last column of Table 6.1 this analysis revealed statistically significant differences between the perceptions of students in different classes for all QTI scales. The ANOVA eta^2 values for the Actual Form of the QTI for this component of the study indicate that the amount of variance explained by class membership ranges from 0.14 to 0.41.

Interscale correlations can be used to test the validity of the circular two-dimensional model on which the QTI is based. This model would be validated if interscale correlations were highest between adjacent scales and lowest between scales opposite to one another on the model. Table 6.2 reports interscale correlations for the Actual Form of the QTI with the individual student as the unit of analysis. The figures from this study validate the circumplex pattern of the QTI in that, with a few minor exceptions, the highest correlations are found between scales adjacent on the two-dimensional model (e.g. between helping/friendly and leadership behaviour) and

the lowest correlations between scales opposite to one another on the model (e.g. between helping/friendly and dissatisfied behaviour).

Table 6.2

Correlations (Pearson) Between Scales for Actual Form of the QTI

Scale	HFr	Und	SRe	Unc	Dis	Adm	Str
Lea	0.83 ***	0.84 ***	0.36 ***	-0.55 ***	-0.64 ***	-0.61 ***	-0.41 ***
HFr		0.82 ***	0.48 ***	-0.49 ***	-0.66 ***	-0.61 ***	-0.51 ***
Und			0.43 ***	-0.45 ***	-0.61 ***	-0.60 ***	-0.49 ***
SRe				0.06	-0.08	-0.17 *	-0.24 ***
Unc					0.68 ***	0.70 ***	0.48 ***
Dis						0.69 ***	0.66 ***
Adm							0.68 ***

* $p < 0.05$ *** $p < 0.001$ N = 217

6.3 RELIABILITY AND VALIDITY OF THE SLEI

Table 6.3 reports three reliability and validity statistics for student responses to the 35-item Actual Form of the SLEI used in this study. Statistics relating to the instrument's internal consistency, discriminant validity and ability to differentiate between the perceptions of students in different classrooms are reported for the target sample of students used in this stage of the study, with the individual student as the unit of analysis. It shows that, for the Actual Form of the SLEI, the alpha reliability figures ranged from 0.51 to 0.66. All scales except Open-endedness have acceptable reliability for research purposes.

The mean correlation of a scale with other scales was used as a convenient measure of the discriminant validity of the SLEI. As shown in Table 6.3, for the Actual Form, mean correlations ranged from 0.11 to 0.34. These discriminant validity values indicate that the SLEI measures distinct aspects of the laboratory learning environment, as previously reported by Fraser et al. (1993).

As previously indicated, it is desirable that classroom environment instruments are able to discriminate between the perceptions of students in different classes. The eta^2 values reported in Table 6.3 range from 0.04 to 0.10 but only the Rule Clarity

scale differentiated significantly ($p<0.05$) between the perceptions of students in different classes.

Table 6.3

Internal Consistency (Cronbach Alpha Coefficient) and Ability to Differentiate Between Classrooms for the Actual Form of the SLEI

Scale	Alpha Reliability	Mean correlation with other scales	ANOVA Results (eta^2)
Student Cohesiveness (SC)	0.61	0.33	0.09
Open-endedness (OE)	0.51	0.11	0.09
Integration (I)	0.62	0.30	0.04
Rule Clarity (RC)	0.66	0.27	0.10 *
Material Environment (ME)	0.63	0.34	0.07

* $p< 0.05$ N= 218

6.4 RELIABILITY AND VALIDITY OF THE ATTITUDE SCALE

Student attitudes were assessed with a seven-item Attitude to This Class instrument adapted from the Test of Science-Related Attitudes [TOSRA] (Fraser, 1991). This scale has been used in several previous studies involving students in science classes and has been shown to have satisfactory internal consistency (e.g., Fisher, Fraser, & Rickards, 1997; Fisher, Henderson, & Fraser, 1995). The reliability of this scale is shown clearly in the alpha score of 0.83 with the individual student as the unit of analysis. This shows a high level of correlation between the seven items in the scale and therefore a high level of internal consistency.

6.5 COMPARISON OF PRE-INTERVENTION AND POST-INTERVENTION DATA FOR THE QTI AND SLEI

In the initial phase of the study students responded to the Actual and Preferred Forms of the QTI and SLEI. The resulting data allowed comparisons to be made between students' perceptions of certain aspects of their actual and preferred classroom environments. In the reassessment phase of the study, students responded to the Actual Forms of the QTI and SLEI. The additional data obtained allowed further

comparisons to be made following the development and implementation of the learning environment improvement plans outlined in Chapter 4.

6.5.1 QTI Data and Analysis

Table 6.4 summarises data obtained from students' pre-intervention and post-intervention responses to the QTI. To further facilitate comparisons between students' perceptions of teacher interpersonal behaviours, the item means for each scale for the pre-intervention and post-intervention data are presented graphically in Figure 6.1.

The data depicted in Figure 6.1 indicate that when comparing students' perceptions of the actual interpersonal behaviours displayed by teachers in the pre-intervention and post-intervention phases of the study, it can be seen that the perceived post-intervention behaviours are closer to the teacher interpersonal behaviours preferred by students for the Leadership, Helping/Friendly, Understanding and Student Responsibility scales of the QTI. It must be noted however, that the differences in pre-intervention and post-intervention item means were only statistically significant for the Helping/Friendly and Student Responsibility scales.

Table 6.4

Item Means and Standard Deviations for the Pre-Intervention and Post-Intervention Data from the QTI

Scale	Item Mean					Standard Deviation		
	Pre-Intervention Preferred (PreP)	Pre-Intervention Actual (PreA)	Post-Intervention Actual (PostA)	Difference (PostA - PreA)	Difference (PreP - PostA)	Pre-Intervention Preferred	Pre-Intervention Actual	Post-Intervention Actual
Leadership	3.22	2.43	2.49	0.06	0.73 ***	0.71	0.66	0.91
Helping/Friendly	3.49	2.35	2.56	0.21 *	0.93 ***	0.71	0.89	1.10
Understanding	3.45	2.40	2.46	0.06	0.99 ***	0.73	0.79	0.97
Student Responsibility	2.45	1.54	1.72	0.18 **	0.91 ***	0.77	0.66	0.73
Uncertain	1.04	1.11	1.29	0.18 *	-0.25 **	0.89	0.67	0.82
Dissatisfied	0.82	1.40	1.47	0.07	-0.65 ***	0.89	0.80	0.94
Admonishing	0.95	1.68	1.83	0.15	-0.88 ***	0.90	0.89	0.95
Strict	1.32	1.94	1.95	0.01	-0.63 ***	0.84	0.64	0.73

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ $N_{\text{pre-intervention}} = 208$ $N_{\text{post-intervention}} = 217$

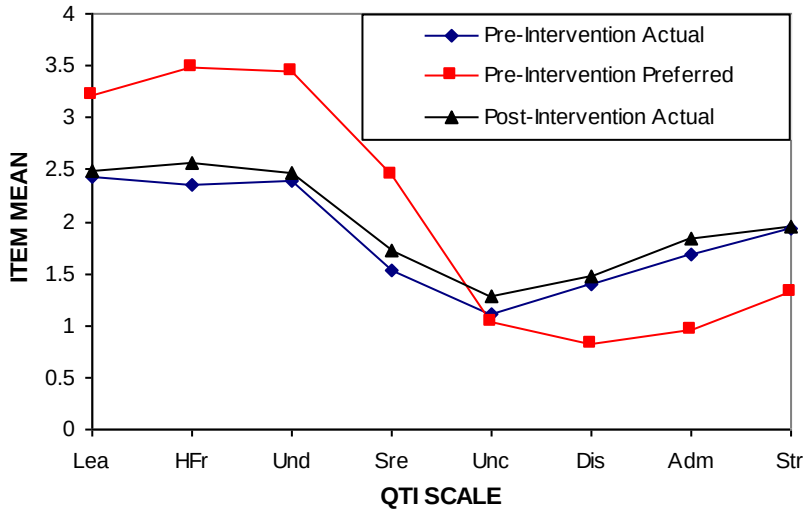

Figure 6.1. *Item means for the QTI for pre-intervention and post-intervention student perceptions of the interpersonal behaviours displayed by their science teacher.*

6.5.2 SLEI Data and Analysis

Table 6.5 summarises data obtained from students' pre-intervention and post-intervention responses to the SLEI. To more easily compare students' perceptions of their science laboratory environment in the pre-intervention and post-intervention phases of the study, the item means for each scale of the SLEI for the pre-intervention and post-intervention data are presented graphically in Figure 6.2.

The data depicted in Figure 6.2 indicate that when students' pre-intervention and post-intervention perceptions of their actual science laboratory environments are compared, their post-intervention perceptions are closer to their preferred environments for the Student Cohesiveness and Open-endedness scales. For the Integration, Rule Clarity and Material Environment scales of the SLEI the post-intervention item means for the Actual Form were higher than the pre-intervention item means for the Preferred Form. The differences in pre-intervention and post-intervention item means were statistically significant for all SLEI scales except Student Cohesiveness and Rule Clarity.

Table 6.5

Item Means and Standard Deviations for the Pre-Intervention and Post-Intervention Data from the SLEI

Scale	Item Mean					Standard Deviation		
	Pre-Intervention Preferred (PreP)	Pre-Intervention Actual (PreA)	Post-Intervention Actual (PostA)	Difference (PostA - PreA)	Difference (PreP - PostA)	Pre-Intervention Preferred	Pre-Intervention Actual	Post-Intervention Actual
Student Cohesiveness	3.55	3.04	3.48	0.44 **	0.07	0.53	0.49	0.65
Open-endedness	3.40	2.52	2.67	0.15 **	0.73 ***	0.59	0.48	0.58
Integration	2.91	2.58	3.38	0.80 ***	-0.47 ***	0.51	0.44	0.64
Rule Clarity	3.50	3.43	3.60	0.17 **	-0.10	0.59	0.57	0.67
Material Environment	2.94	2.88	3.24	0.36 ***	-0.30 ***	0.46	0.45	0.75

$N_{\text{pre-intervention}} = 208$ $N_{\text{post-intervention}} = 218$ ** $p < 0.01$ * * * $p < 0.001$

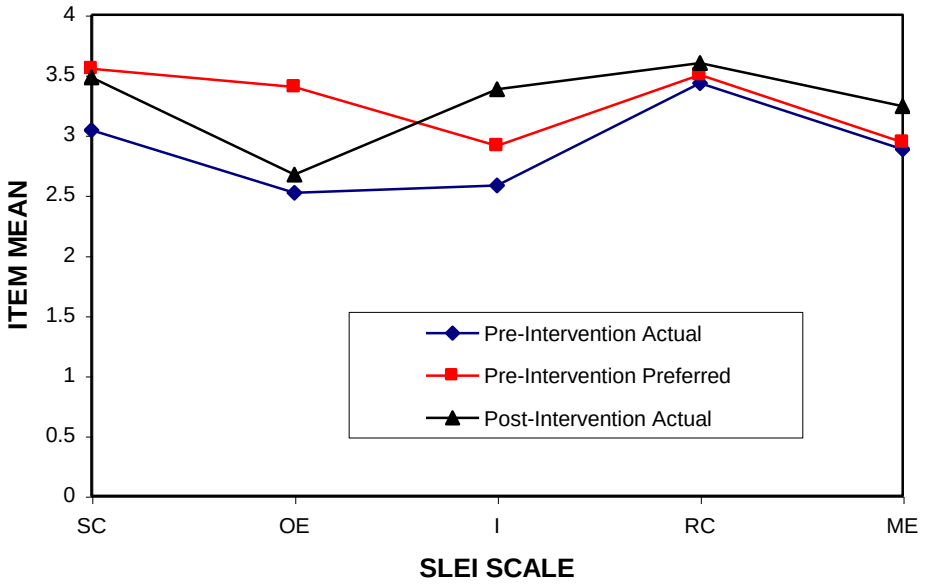

Figure 6.2. *Item means for the SLEI for pre-intervention and post-intervention student perceptions of their science laboratory learning environment.*

6.6 ASSOCIATIONS BETWEEN STUDENTS' COGNITIVE AND ATTITUDINAL LEARNING OUTCOMES IN SCIENCE AND ASPECTS OF THE LEARNING ENVIRONMENT

The two types of student outcome considered are the attitudinal outcome as measured by the scale detailed in Chapter 3 and the cognitive outcome determined by science assessment completed during the year. This assessment was also discussed in Chapter 3

Using the scales of the QTI and SLEI as independent variables, associations were determined with cognitive and attitudinal outcomes as mentioned above. In order to investigate these associations the data were analysed using both simple and multiple correlations. Whereas the simple correlation (r) describes the bivariate association between an outcome and a scale, the standardized regression weight (β) characterizes the association between an outcome and a particular scale when all other dimensions are controlled.

6.6.1 Associations between QTI Scales and Students' Attitudinal and Cognitive Outcomes

This section focuses on associations between students' perceptions of teacher interpersonal behaviours and students' attitudinal and cognitive outcomes. Examination of the simple correlation (r) results in Table 6.6 discloses that of the eight possible relationships between teacher interpersonal behaviour and the outcome variable of attitude, seven are statistically significant (p<0.05). This is 17 times that expected by chance alone. However, a similar examination of the multiple correlation (β) weights reveals that out of the eight possible relationships only one is statistically significant (p<0.05). This is still two times that expected by chance alone.

Table 6.6

Associations between QTI Scales and Students' Attitudinal and Cognitive Outcomes in Terms of Simple Correlations (r) and Standardized Regression Coefficients (β)

Scale	Attitude		Result	
	r	β	r	β
Leadership	0.34 **	0.02	0.06	0.20
Helping/Friendly	0.45 **	0.10	0.03	0.08
Understanding	0.44 **	0.13	0.01	-0.13
Student Responsibility	0.35 **	0.20 *	-0.04	-0.09
Uncertain	-0.12	0.05	-0.05	-0.08
Dissatisfied	-0.33 **	-0.05	0.00	0.14
Admonishing	-0.33 **	-0.13	0.00	0.11
Strict	-0.34 **	-0.09	-0.01	-0.10
Multiple Correlation, R	0.51 ***		0.15	
R^2	0.26		0.02	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ N = 217

Further examination of the simple correlation (r) coefficients in Table 6.6 indicate statistically significant and quite strong associations between students' attitudinal outcomes and all QTI scales except Uncertain. Simple correlation coefficients were highest for the scales of Helping/Friendly and Understanding. The scales of

Leadership, Helping/Friendly, Understanding and Student Responsibility each had positive correlations with students' attitudes towards their science teachers' interpersonal behaviours. Conversely, the scales of Dissatisfied, Admonishing and Strict interpersonal behaviour each had negative correlations. This is consistent with the finding's reported with students in the Netherlands, the USA and Australia (Rawnsley & Fisher, 1998; Brekelmans, Levy & Rodriguez, 1993; Wubbels, Brekelmans & Hooymayers, 1991). These findings suggest that in classes where students view their teacher as predominantly showing high levels of leadership, helping/friendly and understanding behaviours and providing them with high levels of responsibility and freedom, students have more positive attitudes towards their science classes. On the other hand, where students perceive their science teachers to display high levels of strict, admonishing and dissatisfied behaviour, their attitudes towards science are less positive. The β weights show that only the association between student attitudes and the Student Responsibility scale of the QTI retains its significance in the more conservative multivariate test with all other QTI scales controlled. This more conservative analysis suggests that of the teacher behaviours identified earlier as promoting positive student attitudes to science, it is those associated with the Student Responsibility scale that are most influential. No statistically significant associations were found between students' cognitive outcomes and interpersonal student-teacher behaviours.

The multiple correlation (R) value of 0.51, which is statistically significant ($p<0.001$), indicates that associations were strongest between students' perceptions of interpersonal teacher behaviour and attitudinal outcomes. The R^2 value of 0.26 indicates that 26% of the variance in students' attitudes to their science classes can be attributed to their perceptions of teacher interpersonal behaviours.

6.6.2 Associations between SLEI Scales and Students' Attitudinal and Cognitive Outcomes

The focus of this section is on associations between students' perceptions of their science laboratory learning environment and their attitudinal and cognitive outcomes. The data presented in Table 6.7 show associations between students' perceptions of the laboratory learning environment and attitudinal and cognitive outcomes. An

examination of the simple correlation (*r*) results in Table 6.7 indicates that of the five possible relationships between the science laboratory learning environment and students' attitudes towards science classes, four are statistically significant ($p<0.05$). This is 16 times that expected by chance alone. A similar examination of the multiple correlation (β) weights reveals that three of the five relationships remain statistically significant ($p<0.05$). This is still 12 times that expected by chance alone.

Table 6.7

Associations between SLEI Scales and Students' Attitudinal and Cognitive Outcomes in Terms of Simple Correlations (r) and Standardized Regression Coefficients (β)

Scale	Attitude		Result	
	r	β	*r*	β
Student Cohesiveness	0.27 **	0.16 *	0.13	0.13
Open-endedness	0.13	0.11	-0.03	-0.03
Integration	0.29 **	0.17 *	0.04	-0.02
Rule Clarity	0.28 **	0.19 *	-0.08	0.05
Material Environment	0.18 **	-0.04	0.04	-0.03
Multiple Correlation, R	0.39 ***		0.14	
R^2	0.15		0.02	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ N = 217

Simple correlation figures indicate statistically significant associations between attitudinal outcomes and all SLEI scales except Open-endedness. Beta weight values indicate that the Student Cohesiveness, Rule Clarity and Integration scales had similar degrees of association with attitudinal outcomes when other SLEI scales were controlled. These findings suggest that positive student attitudes to science classes are promoted in laboratory environments where students perceive high levels of student cohesiveness, rule clarity and integration and a high quality material environment. Further examination of the associations between students' attitudinal outcomes and their perceptions of science laboratory environments, but focusing on the more conservative standard regression weights (β) data, indicates that the Student Cohesiveness, Integration and Rule Clarity scales retain their statistical significance. These scales are positively correlated with attitude and because they withstood the more conservative analysis are the most influential in promoting positive attitudes in

science laboratory learning environments. As with the QTI, no statistically significant associations were found between students' cognitive outcomes and any of the SLEI scales.

Examination of the multiple correlation figures reveals a similar pattern to those in Table 6.6 for the QTI, with associations strongest with attitudinal outcomes. The R^2 value of 15 indicates that 15% of the variance in students' attitudes to their science classes can be attributed to their perceptions of their laboratory learning environment.

Newby and Fisher (2000) conducted a study which used a two-dimensional hierarchical model to investigate the relationship between computer laboratory environments and student outcomes. Although little direct association was found between computer laboratory environment and achievement, the model indicated that there is an indirect effect of environment on achievement through attitude. In the current study no statistically significant associations were found between student-teacher interpersonal behaviours or the science laboratory environment and student achievement, even though student achievement improved during the study, as shown in Table 6.8. Based on the findings of Newby and Fisher (2000) this could be an indirect effect of the positive associations found between some student-teacher interpersonal behaviours and certain aspects of the science laboratory learning environment and student attitudes to science classes.

Table 6.8

Junior Science Results 1996 - 2000

Year	% of Students Obtaining														
	VHA			HA			SA			LA			VLA		
	Yr 10	Yr 9	Yr 8	Yr 10	Yr 9	Yr 8	Yr 10	Yr 9	Yr 8	Yr 10	Yr 9	Yr 8	Yr 10	Yr 9	Yr 8
1996	4.8	6.5	1.9	2.4	11.9	4.9	15.5	21.7	24.5	38.1	33.7	32.4	39.2	26.2	36.3
1997	9.1	5.9	4.7	12.5	6.8	15.1	15.9	34.3	21.7	30.7	35.4	26.4	31.8	17.6	32.1
1998	19.5	10.4	10.0	19.5	15.1	25.4	26.2	23.6	26.4	27.2	28.3	28.2	7.6	22.6	10.0
1999	9.9	11.5	12.1	18.8	15.9	30.8	29.7	31.0	32.8	17.8	17.7	11.2	23.8	23.9	13.1
2000	4.1	11.7	15.5	17.1	18.1	23.7	38.2	34.2	28.9	16.3	17.1	17.5	24.3	18.9	14.4

6.7 SUMMARY

This chapter reported on the findings related to the reassessment phase of the study.

In the reflection and discussion phase of the study participating teachers decided which aspects of the classroom environment they were going to target for change in the intervention phase of the study. They decided to target the Leadership scale from the QTI and the Open-endedness scale from the SLEI. When comparing pre-intervention and post-intervention item means for each of these scales, it was found that while the mean difference for the Open-endedness scale was statistically significant, that for the Leadership scale was not. It would appear then, that the intervention process reduced the disparity between students' actual and preferred perceptions in relation to the degree of open-endedness associated with laboratory activities but that it did not result in teachers exhibiting stronger leadership behaviours.

The study originated to address the need to improve Junior Science outcomes in a particular school. Two types of outcome were considered – cognitive achievement and attitude to science classes. Data collected in the reassessment phase of the study showed no statistically significant associations between students' cognitive outcomes and aspects of the learning environment such as teacher interpersonal behaviours and the science laboratory environment. Despite these findings, students' cognitive outcomes did improve considerably throughout the course of the study.

In relation to attitudinal outcomes, data collected during the reassessment phase of the study showed statistically significant associations between some aspects of the learning environment and student attitudes to science classes. These associations suggest that students will be more positive towards science if they perceive their teachers to demonstrate strong leadership, helping/friendly and understanding behaviours and provide them with high levels of responsibility and freedom. Furthermore, students will be more positive towards their science studies if they perceive their laboratory environments to feature high levels of cohesiveness, integration and rule clarity.

The final chapter draws together and examines the findings of this study. It also addresses the limitations of this study and identifies areas of possible further research.

CHAPTER 7

CONCLUSIONS

7.1 INTRODUCTION

This chapter provides a synthesis of the material presented in the preceding chapters with the aim of answering the research questions posed in Chapter 3. Conclusions are then drawn from these answers, the significance of the study noted, limitations of the study discussed, directions for further research indicated and concluding remarks made.

Chapter 1 outlined the origins of this study and presented an overview of this thesis. Chapter 2 established the conceptual framework for this study by reviewing the literature related to past research on learning environments. Particular reference was made to the development and past use of the QTI and SLEI, teachers' practical attempts to improve their classroom environments and associations between student outcomes and aspects of their learning environment. Chapter 3 presented the research questions and gave a detailed description of the methodology used throughout the study with particular emphasis on the five-step classroom environment improvement process. The reliability and validity of the QTI and SLEI for the sample of students used in the pre-intervention phase of the study were confirmed in the figures presented in Chapter 4. A comparison of students' actual and preferred perceptions of teacher interpersonal behaviour and of the laboratory learning environment was reported in Chapter 4 where the focus was on quantitative data collected during the first four steps of the learning environment improvement process. In Chapter 5 qualitative information relating to the first four steps of the learning environment improvement process and supplementing the quantitative data presented in Chapter 4 was reported. Chapter 6 focused on the reassessment phase of the study and identified changes to teacher interpersonal behaviour and the laboratory learning environment that occurred over the course of the study. It also described associations between students' perceptions of teacher interpersonal

behaviour and their attitudinal and cognitive outcomes as well as those between students' perceptions of the laboratory learning environment and their attitudinal and cognitive outcomes.

Although numerous past studies have examined associations between student perceptions of the learning environment in science classes and student outcomes, this study is unique in that it has assessed student perceptions of two distinct aspects of the learning environment (namely teacher-student interactions and the laboratory learning environment), incorporated a step-by-step process designed to improve targeted aspects of the learning environment and examined student outcomes in two areas – attitude to science and cognitive achievement in science.

7.2 MAJOR FINDINGS OF THIS STUDY

There were five research questions posed in this study and each is restated below and addressed in turn.

Question One

Are the QTI and SLEI valid and reliable instruments for use in Queensland schools?

In keeping with previous learning environment research, the reliability and validity of the instruments was established (see Sections 4.1.2, 4.2.2, 6.2 and 6.3).

For the scales of the QTI, the Cronbach alpha reliability ranged from 0.82 to 0.94 for the Actual Form and from 0.92 to 0.96 for the Preferred Form for data collected during the pre-intervention phase of the study. During the post-intervention phase of the study it ranged from 0.64 to 0.89 for the Actual Form. It can be concluded that both forms of the QTI are reliable as all values are above the threshold value of 0.06 (Nunnally, 1967).

In order to determine whether the Actual Form of each scale of the QTI is able to differentiate between student perceptions between classrooms, an analysis of variance (ANOVA) was calculated. For the pre-intervention phase of the study

statistically significant values of eta^2 ranged from 0.11 to 0.34 while for the post-intervention phase of the study they ranged from 0.14 to 0.41. Data from the pre-intervention phase of the study showed that the Uncertain scale was the only one unable to differentiate between the perceptions of students in different classrooms to a statistically significant extent.

Interscale correlations were used to test the validity of the circular two-dimensional model on which the QTI is based. Each scale should correlate most highly with the scale next to it in the model while lowest correlations should occur between scales opposite in the model. This pattern is exemplified by considering correlations between the Dissatisfied scale and the seven other scales on the Actual Form of the QTI for the pre-intervention phase of the study. Highest correlations occur between the Dissatisfied and Admonishing scales (0.59) and the Dissatisfied and Uncertain scales (0.52) which are next to each other in the model whilst lowest correlations occur between the Dissatisfied and Leadership scales (-0.41), the Dissatisfied and Understanding scales (-0.49) and the Dissatisfied and Helping/Friendly scales (-0.51) which are on opposite sides of the model. Similar results were obtained for other scales using both pre-intervention and post-intervention data thus confirming the validity of the QTI.

Similarly to the QTI, alpha reliabilities for the Actual and Preferred Forms of the SLEI scales were computed. They ranged from 0.75 to 0.87 for the Actual Form and from 0.75 to 0.88 for the Preferred Form in the pre-intervention phase of the study. In the post-intervention phase they ranged from 0.51 to 0.66 for the Actual Form of the SLEI. The alpha reliability of the Open-endedness scale was the only one below the 0.6 threshold and therefore it can be concluded that the both forms of the SLEI are reliable.

The eta^2 value, indicating the percentage of variance in perception of learning environment characteristics attributable to class membership ranged from 0.06 to 0.33 for the Actual Form of the SLEI in the pre-intervention phase of the study, however only the Student Cohesiveness, Open-endedness and Material Environment scales differentiated significantly ($p<0.01$) between classes. For the post-intervention phase of the study the eta^2 value ranged from 0.04 to 0.10 but only the

Rule Clarity scale differentiated significantly ($p<0.05$) between the perceptions of students in different classes.

In keeping with past learning environment validations, information supporting the discriminant validity through the mean correlation of a scale with other scales was determined. The mean correlation of a scale with other scales ranged from 0.15 to 0.29 for the Actual Form and from 0.10 to 0.24 for the Preferred Form of the SLEI in the pre-intervention phase of the study and from 0.11 to 0.34 for the Actual Form in the post-intervention phase of the study. These figures indicate that the SLEI measures distinct, although somewhat overlapping, aspects of the laboratory environment.

Question Two

How do junior science students' perceptions of the actual teacher-student interpersonal behaviours being exhibited in their classrooms differ from those that they would prefer to be occurring:

(a) prior to the intervention process?

In Chapter 4, students' perceptions of teacher interpersonal behaviour in their science classrooms are compared with the interpersonal behaviour they prefer their teachers to exhibit. The data (Section 4.3.1) reveal that students prefer teachers who show stronger leadership, who are more helping/friendly and understanding, and who give them more responsibility and freedom. They also prefer teachers who display less dissatisfied, admonishing and strict behaviours. The data supporting these statements are statistically significant ($p<0.0001$). It is evident from the results reported in Chapter 4 that students prefer a more positive learning environment with regard to aspects of teacher interpersonal behaviour.

(b) **after the intervention process?**

A comparison of pre-intervention and post-intervention data show that over the duration of the study, actual/preferred discrepancies were reduced on the Helping/Friendly, Student Responsibility and Uncertain scales of the QTI. These differences were statistically significant to at least the $p<0.01$ level.

Question Three

How do junior science students' perceptions of their actual laboratory learning environments differ from their preferred ones:

(a) prior to the intervention process?

The data (Section 4.3.2) indicate that students prefer to work in a science laboratory environment where there are higher levels of student cohesiveness, open-endedness, integration and rule clarity as well as a better material environment.

(b) **after the intervention process**?

After a comparison of the pre-intervention and post-intervention data, considering only statistically significant differences, while students still prefer more open-endedness the disparity between the actual and preferred discrepancies has been reduced. The other notable changes that occurred over the course of the study are that initially students preferred a better material environment and more integration but the post-intervention data indicated that the material environment was actually better than that perceived by students to be the ideal and that more integration than desired was occurring.

Question Four

What associations exist between junior science students' outcomes (attitudinal and cognitive) and their perceptions of teacher-student interpersonal behaviours?

The results presented in Chapter 6 indicate that students' perceptions of teacher interpersonal behaviour are associated strongly with students' attitudinal outcomes. Simple correlational analysis revealed that the QTI scales of Leadership, Helping/Friendly, Understanding and Student Responsibility had a positive influence on students' attitude towards science, and that the scales of Dissatisfied, Admonishing and Strict had a negative influence.

The results of the more conservative multiple regression analysis indicated that behaviours associated with the Student Responsibility scale are the most influential in promoting positive student attitudes to science.

No statistically significant associations were found between students' cognitive outcomes and teacher-student interpersonal behaviours.

Question Five

What associations exist between junior science students' outcomes (attitudinal and cognitive) and their perceptions of laboratory learning environments?

Students' perceptions of the laboratory learning environment were also found to be associated strongly with students' attitudinal outcomes. Simple correlational analysis revealed that the SLEI scales of Student Cohesiveness, Integration, Rule Clarity and Material Environment all had a positive influence on students' attitude towards science.

The results of the more conservative multiple regression analysis indicated that positive student attitudes were associated most strongly with students' perceptions of higher levels of integration of the practical and theory components of their science course, a greater degree of rule clarity and better student cohesiveness.

No statistically significant associations were found between students' cognitive outcomes and their perceptions of the laboratory learning environment.

7.3 IMPLICATIONS OF THIS STUDY

The implications of this study can be placed into one of three overlapping focus areas – identifying actual/preferred discrepancies in aspects of the learning environment, identifying features of the learning environment which have positive associations with attitudinal outcomes and implementing a process to bring about changes to aspects of the learning environment.

This study provides evidence of substantial differences between science students' perceptions of their actual and preferred learning environment. Because previous research has indicated that minimizing the disparity between students' actual and preferred learning environments could promote more favourable student outcomes (Fisher & Fraser, 1983; Fraser, 1994) this study provides teachers with information

about aspects of the learning environment that, if altered, are likely to lead to improvements in students' attitudes and cognitive achievement.

Regarding teacher interpersonal behaviour, the results of this study imply that science teachers would promote a more positive learning environment by showing strong leadership, being more helping/friendly and understanding, being less dissatisfied, admonishing and strict, but above all giving their students more responsibility and freedom.

In relation to the laboratory learning environment, the results of this study imply that students would perceive a more positive environment were there to be greater cohesiveness amongst students, increased integration between laboratory activities and the theoretical components of their science course, and a greater degree of rule clarity in the laboratory.

With the increasing accountability of performance indicators and school comparisons, the direct implications of associations between student attitude and achievement become important factors for any teacher wishing to improve the outcomes of their students and also for any school wishing to improve its performance. The outcomes of a number of studies (Wubbels & Brekelmans, 1998; Fisher, Fraser, & Wubbels, 1993; Fisher, Henderson, & Fraser, 1995; Fisher & Rickards, 1997; Rawnsley & Fisher, 1997; Waldrip & Fisher, 2003) suggest that if teachers wish to improve the achievement and attitudes of their students they should ensure that those behaviours that have been found to be empirically linked to these variables are present in their classrooms. This study has indicated that a number of aspects of teacher interpersonal behaviour and the laboratory learning environment are associated with students' attitudinal outcomes. In particular, more favourable student attitudes tend to be fostered where students perceive their teacher to give them more responsibility and freedom, that there is a greater degree of integration between laboratory activities and the theory components of their science course, a higher level of rule clarity in the laboratory and more cohesiveness between students.

Even though the results of this study did not identify any associations between students' perceptions of teacher interpersonal behaviour or aspects of their laboratory

learning environment and their cognitive outcomes, there is an established link between student attitudes and cognitive outcomes. Newby and Fisher (2000) reported on a study, the results of which supported the hypothesis that the learning environment affects achievement indirectly through its effect on attitude.

A comparison of pre-intervention and post-intervention data implied that the classroom environment improvement plans brought about some changes in teacher interpersonal behaviour and aspects of the laboratory learning environment.

One of the key outcomes of this study is that it has provided a number of science teachers with first-hand experience of monitoring, evaluating and attempting to change what is happening in their classrooms to promote more desirable student attitudinal and cognitive outcomes i.e. to improve the quality of teaching and learning.

This study documents a step-by-step process that can be used by classroom teachers to assess, evaluate and improve aspects of the classroom and laboratory learning environments.

7.4 LIMITATIONS OF THE STUDY

The generalisability of this study is limited as all students and teachers who participated in the study were from the same school. The conclusions drawn in relation to this sample can relate only to this sample. It should be with caution that any inferences are made with regards to the situation in other schools.

The outcome measure used to assess cognitive achievement was school specific assessment developed by individual teachers. Not all students completed the same assessment throughout a particular school year. Each teacher determined the final grade for each of the students in their class. The achievement outcome of final grades is not strictly comparable across students in the sample.

Due to the small number of teachers participating in the study, the length of the study and teacher transfers in and out of the school, the only teacher who participated in

the entire study was the researcher. The change in participating teachers occurred progressively across the duration of the study and despite the efforts of the researcher there could be no guarantee that the teachers joining the study had the same degree of understanding, ownership and commitment as the original participants.

When this study was first conceptualized, it was anticipated that it would have a clear cut starting and finishing point. Due to input from participating teachers the finishing point kept being extended. As mentioned in the previous paragraph, the teachers involved in the study changed over time. Learning environment improvement plans other than the original ones described in Chapter 4 were designed and implemented. There is no guarantee that these were designed to bring about change to those aspects of the classroom environment targeted by the original ones. Thus the data collected in the post-intervention phase of the study may not directly relate to the original set of learning environment improvement plans that were developed and implemented. This notion is supported by the fact that for the Leadership scale of the QTI, which was the aspect of teacher interpersonal behaviour targeted for change in the original learning environment improvement plans, there was no statistically significant decrease in the actual/preferred discrepancies over the duration of the study. There were, however, statistically significant decreases in the actual/preferred discrepancies for other QTI scales, namely Helping/Friendly, Student Responsibility and Uncertain. In relation to the laboratory learning environment, the Open-endedness scale of the SLEI was targeted for change in the original classroom environment improvement plans. While there was a statistically significant reduction in the actual/preferred difference for this scale over the duration of the study, this reduction was less than that for each of the other SLEI scales.

7.5 SUGGESTIONS FOR FURTHER RESEARCH

Given that the significance of this thesis – combining theory and practice – stems from the statement ‘It is not enough to collect data: something must be done with it’ (Frieberg & Stein, 1999), the suggestions for further research outlined below all have relevance for the classroom teacher in that they can be used to improve the learning environment and hence improve student outcomes.

Do student perceptions change as they progress through their years of formal education? Maximising student outcomes is a fundamental role of the teacher. Schools, and hence teachers, are increasingly being held accountable for the outcomes of their students. Previous studies of classroom environments have demonstrated that perceived classroom environments can predict student learning and that a key to improving student outcomes is to create learning environments that are characterized by those features that have been linked empirically with favourable student outcomes. Further research into the perceptions of students at different stages of their formal education would provide more fine-tuned information about the specific features of learning environments that should be evident in the classrooms of students in different stages of schooling e.g. lower, middle or upper primary or secondary.

Do student perceptions change from subject to subject? Still with a focus on maximizing student outcomes, research into the perceptions of students in different subjects could provide valuable information as to whether or not similar aspects of the learning environment in different subjects are linked empirically with favourable student outcomes. This may necessitate the modification of already developed classroom environment questionnaires or even the development of new ones as many of those currently in use have been developed for use in science or mathematics classrooms.

Are the perceptions of students in government schools the same as those in non-government schools? This is an area for potential research that does not seem to have been touched on. In particular, it could be worth determining whether students from the different sectors have different perceptions of their actual and preferred classroom environments.

Involvement in this study has provided a number of teachers with the skills to conduct further research in their own classrooms. They may choose to continue to focus on their science classes and use the QTI and/or SLEI or they may move their investigations to other subject areas or to other characteristics of the learning environment and use one or more of the wide range of learning environment instruments that have already been developed and found to be statistically valid and

reliable. Even though this research may not move into previously uncharted waters, it is hoped that the word will spread and that other teachers will engage in research projects to evaluate and improve their own effectiveness and hence the outcomes of their students.

From the perspective of a school-based practitioner it is evident that many teachers constantly face problems which relate to the teacher-student relationship in the classroom. Student perceptions of this relationship are strongly linked to their attitudinal and cognitive outcomes (Brekelmans, Wubbels, & den Brok, 2002; den Brok, 2001; den Brok, Brekelmans, & Wubbels, 2004; Fraser, 1998a; Henderson, Fisher, & Fraser, 2000; Wubbels & Levy, 1993). Use of a questionnaire such as the QTI by classroom teachers to gather and act on information about how their students perceive their interpersonal behaviour in relation to how they would prefer them to behave can only be of benefit to both teachers and their students. For this to have the greatest possible impact, classroom teachers need to be part of the research process.

7.6 FINAL COMMENTS

This study has identified discrepancies between the perceptions of students in relation to the actual and preferred interpersonal behaviour displayed by their science teachers. It has also reported a step-by-step process used in an attempt to minimize these discrepancies in some targeted aspects of teacher interpersonal behaviour and the laboratory learning environment. Another component of this study has identified associations between students' perceptions of their science laboratory environment and attitudinal outcomes and between their perceptions of their teachers' interpersonal behaviour and attitudinal outcomes.

The results reported in this thesis have implications for teachers of science, and possibly other subjects, who are interested in the development of positive attitudes in their students and in their students' cognitive outcomes.

The questionnaires used in this study allow researchers and teachers to identify perceptions of the science laboratory learning environment and teacher interpersonal behaviour in an economical and practical manner.

The analysis of associations implied by the results of this study could have implications for improving student attitudes and achievement by utilizing students' perceptions of the learning environment. Modifying the learning environment to accommodate students' perceptions warrants further investigation, particularly by practicing teachers.

This thesis provides a practical example of how a classroom teacher can take on the role of researcher as they attempt to bring about changes to their classroom practices in order to improve the outcomes of their students. This can be done individually or as part of a team.

One of the highlights of this study was the extent to which the participating teachers, particularly the original team, worked together in an attempt to change aspects of their classroom environment in order to improve the outcomes of their students. They took note of information provided by their students and acted on it . In doing this they immersed themselves in a challenging period of professional development and growth which, for most of them, extended beyond the duration of the study. They are to be commended for their efforts.

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APPENDICES

APPENDIX A ACTUAL AND PREFERRED STUDENT FORMS OF THE QTI

QUESTIONNAIRE ON TEACHER INTERACTION

YOUR SCIENCE TEACHER

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

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

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

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

Code: _____ Gender: Male/Female

		Never				Always	Teacher Use
1.	This teacher talks enthusiastically about her/his subject.	0	1	2	3	4	Lea
2.	This teacher trusts us.	0	1	2	3	4	Und
3.	This teacher seems uncertain.	0	1	2	3	4	Unc
4.	This teacher gets angry unexpectedly.	0	1	2	3	4	Adm
5.	This teacher explains things clearly.	0	1	2	3	4	Lea
6.	If we don't agree with this teacher, we can talk about it.	0	1	2	3	4	Und
7.	This teacher is hesitant.	0	1	2	3	4	Unc
8.	This teacher gets angry quickly.	0	1	2	3	4	Adm
9.	This teacher holds our attention.	0	1	2	3	4	Lea
10.	This teacher is willing to explain things again.	0	1	2	3	4	Und
11.	This teacher acts as if she/he does not know what to do.	0	1	2	3	4	Unc
12.	This teacher is too quick to correct us when we break a rule.	0	1	2	3	4	Adm
13.	This teacher knows everything that goes on in the classroom.	0	1	2	3	4	Lea
14.	If we have something to say, this teacher will listen.	0	1	2	3	4	Und
15.	This teacher lets us boss her/him around.	0	1	2	3	4	Unc
16.	This teacher is impatient.	0	1	2	3	4	Adm
17.	This teacher is a good leader.	0	1	2	3	4	Lea
18.	This teacher realises when we don't understand.	0	1	2	3	4	Und
19.	This teacher is not sure what to do when we fool around.	0	1	2	3	4	Unc
20.	It is easy to pick a fight with this teacher.	0	1	2	3	4	Adm
21.	This teacher acts confidently.	0	1	2	3	4	Lea
22.	This teacher is patient.	0	1	2	3	4	Und
23.	It's easy to make a fool out of this teacher.	0	1	2	3	4	Unc
24.	This teacher is sarcastic.	0	1	2	3	4	Adm
25.	This teacher helps us with our work.	0	1	2	3	4	HFr
26.	We can decide some things in this teacher's class.	0	1	2	3	4	SRe
27.	This teacher thinks that we cheat.	0	1	2	3	4	Dis
28.	This teacher is strict.	0	1	2	3	4	Str
29.	This teacher is friendly.	0	1	2	3	4	HFr
30.	We can influence this teacher.	0	1	2	3	4	SRe
31.	This teacher thinks that we don't know anything.	0	1	2	3	4	Dis
32.	We have to be silent in this teacher's class.	0	1	2	3	4	Str
33.	This teacher is someone we can depend on.	0	1	2	3	4	HFr
34.	This teacher lets us fool around in class.	0	1	2	3	4	SRe
35.	This teacher puts us down.	0	1	2	3	4	Dis
36.	This teacher's tests are hard.	0	1	2	3	4	Str
37.	This teacher has a sense of humour.	0	1	2	3	4	HFr
38.	This teacher lets us get away with a lot in class.	0	1	2	3	4	SRe
39.	This teacher thinks that we can't do things well.	0	1	2	3	4	Dis
40.	This teacher's standards are very high.	0	1	2	3	4	Str
41.	This teacher can take a joke.	0	1	2	3	4	HFr
42.	This teacher gives us a lot of free time in class.	0	1	2	3	4	SRe
43.	This teacher seems dissatisfied.	0	1	2	3	4	Dis
44.	This teacher is severe when marking papers.	0	1	2	3	4	Str
45.	This teacher's class is pleasant.	0	1	2	3	4	HFr
46.	This teacher is lenient.	0	1	2	3	4	SRe
47.	This teacher is suspicious.	0	1	2	3	4	Dis
48.	We are afraid of this teacher.	0	1	2	3	4	Str

For teacher's use only: Lea ____ Und ____ Unc ____ Adm ____ HFr ____ SRe ____ Dis ____ Str ____

QUESTIONNAIRE ON TEACHER INTERACTION

YOUR IDEAL TEACHER

The following questionnaire asks for your view of an ideal teacher's behaviour. Think about your ideal teacher and keep this ideal teacher in mind as you respond to these sentences. This is NOT a test. Your opinion is what is wanted.

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

	Never				Always
The teacher would express himself/herself clearly.	0	1	2	3	4

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

Code: _____ Gender: Male/Female

		Never				Always	Teacher Use
1.	The teacher would talk enthusiastically about her/his subject.	0	1	2	3	4	Lea
2.	The teacher would trust students.	0	1	2	3	4	Und
3.	The teacher would seem uncertain.	0	1	2	3	4	Unc
4.	The teacher would get angry unexpectedly.	0	1	2	3	4	Adm
5.	The teacher would explain things clearly.	0	1	2	3	4	Lea
6.	If students did not agree with the teacher, they could talk about it.	0	1	2	3	4	Und
7.	The teacher would be hesitant.	0	1	2	3	4	Unc
8.	The teacher would get angry quickly.	0	1	2	3	4	Adm
9.	The teacher would hold the students' attention.	0	1	2	3	4	Lea
10.	The teacher would be willing to explain things again.	0	1	2	3	4	Und
11.	The teacher would act as if she/he did not know what to do.	0	1	2	3	4	Unc
12.	The teacher would be too quick to correct students when they broke a rule.	0	1	2	3	4	Adm
13.	The teacher would know everything that goes on in the classroom.	0	1	2	3	4	Lea
14.	If students had something to say, the teacher would listen.	0	1	2	3	4	Und
15.	The teacher would let students boss her/him around.	0	1	2	3	4	Unc
16.	The teacher would be impatient.	0	1	2	3	4	Adm
17.	The teacher would be a good leader.	0	1	2	3	4	Lea
18.	The teacher would realise when students did not understand.	0	1	2	3	4	Und
19.	The teacher would not be sure what to do when students fooled around.	0	1	2	3	4	Unc
20.	It would be easy for students to pick a fight with the teacher.	0	1	2	3	4	Adm
21.	The teacher would act confidently.	0	1	2	3	4	Lea
22.	The teacher would be patient.	0	1	2	3	4	Und
23.	It's easy to make a fool out of the teacher.	0	1	2	3	4	Unc
24.	The teacher would be sarcastic.	0	1	2	3	4	Adm
25.	The teacher would help students with their work.	0	1	2	3	4	HFr
26.	Students could decide some things in the teacher's class.	0	1	2	3	4	SRe
27.	The teacher would think that students cheat.	0	1	2	3	4	Dis
28.	The teacher would be strict.	0	1	2	3	4	Str
29.	The teacher would be friendly.	0	1	2	3	4	HFr
30.	Students could influence the teacher.	0	1	2	3	4	SRe
31.	The teacher would think that students did not know anything.	0	1	2	3	4	Dis
32.	Students would have to be silent in the teacher's class.	0	1	2	3	4	Str
33.	The teacher would be someone students can depend on.	0	1	2	3	4	HFr
34.	The teacher would let students fool around in class.	0	1	2	3	4	SRe
35.	The teacher would put students down.	0	1	2	3	4	Dis
36.	The teacher's tests would be hard.	0	1	2	3	4	Str
37.	The teacher would have a sense of humour.	0	1	2	3	4	HFr
38.	The teacher would let students get away with a lot in class.	0	1	2	3	4	SRe
39.	The teacher would think that students can't do things well.	0	1	2	3	4	Dis
40.	The teacher's standards would be very high.	0	1	2	3	4	Str
41.	The teacher could take a joke.	0	1	2	3	4	HFr
42.	Theis teacher would give students a lot of free time in class.	0	1	2	3	4	SRe
43.	The teacher would seem dissatisfied.	0	1	2	3	4	Dis
44.	The teacher would be severe when marking papers.	0	1	2	3	4	Str
45.	The teacher's class would be pleasant.	0	1	2	3	4	HFr
46.	The teacher would be lenient.	0	1	2	3	4	SRe
47.	The teacher would be suspicious.	0	1	2	3	4	Dis
48.	Students would be afraid of the teacher.	0	1	2	3	4	Str

For teacher's use only: Lea ____ Und ____ Unc ____ Adm ____ HFr ____ SRe ____ Dis ____ Str ____

APPENDIX B ACTUAL AND PREFERRED STUDENT FORMS OF THE SLEI

SCIENCE LABORATORY ENVIRONMENT INVENTORY (SLEI)

ACTUAL FORM

Directions

This questionnaire contains statements about practices which could take place in this laboratory class. You will be asked **how often** each practice **actually takes place**.

There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

Think about how well each statement describes what this laboratory class is actually like for you. Draw a circle around

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

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 laboratory experiments." You would need to decide whether you thought that you actually choose your partners *Almost Never, Seldom, Sometimes, Often or Very Often.* For example, if you selected *Very Often*, you would circle the number 5 on your answer sheet.

Code: _____ Gender: Male/Female

	*Remember that you are describing your **actual** classroom.*	Almost Never	Seldom	Sometimes	Often	Very Often	For Teacher's Use
1.	I get on well with students in this laboratory class.	1	2	3	4	5	____
2.	There is opportunity for me to pursue my own science interests in this laboratory class.	1	2	3	4	5	____
3.	What I do in our regular science class is unrelated to my laboratory work.	1	2	3	4	5	R ____
4.	My laboratory class has clear rules to guide my activities.	1	2	3	4	5	____
5.	I find that the laboratory is crowded when I am doing experiments.	1	2	3	4	5	R ____
6.	I have little chance to get to know other students in this laboratory class.	1	2	3	4	5	R ____
7.	In this laboratory class, I am required to design my own experiments to solve a given problem.	1	2	3	4	5	____
8.	The laboratory work is unrelated to the topics I am currently studying in my science class.	1	2	3	4	5	R ____
9.	My laboratory class is rather informal and few rules are imposed on me.	1	2	3	4	5	R ____
10.	The equipment and materials that I need for laboratory activities are readily available.	1	2	3	4	5	____
11.	Members of this laboratory class help me.	1	2	3	4	5	____
12.	In my laboratory sessions, other students collect different data than I do for the same problem.	1	2	3	4	5	____
13.	My regular science class work is integrated with laboratory activities.	1	2	3	4	5	____
14.	I am required to follow certain rules in the laboratory.	1	2	3	4	5	____
15.	I am ashamed of the appearance of this laboratory.	1	2	3	4	5	R ____
16.	I get to know the students in this laboratory class well.	1	2	3	4	5	____
17.	I am allowed to go beyond the regular laboratory exercise and do some experimenting of my own.	1	2	3	4	5	____
18.	I use the theory from my regular science class sessions during laboratory activities.	1	2	3	4	5	____
19.	There is a recognised way for me to do things safely in the laboratory.	1	2	3	4	5	____
20.	The laboratory equipment which I use is in poor working order.	1	2	3	4	5	R ____
21.	I am able to depend on other students for help during laboratory classes.	1	2	3	4	5	____
22.	In my laboratory sessions, I do different experiments than some of the other students.	1	2	3	4	5	____
23.	The topics covered in regular science class work are quite different from topics with which I deal in laboratory sessions.	1	2	3	4	5	R ____
24.	There are few fixed rules for me to follow in laboratory sessions.	1	2	3	4	5	R ____
25.	I find that the laboratory is hot and stuffy.	1	2	3	4	5	R ____
26.	It takes me a long time to get to know everybody by his/her first name in this laboratory class.	1	2	3	4	5	R ____
27.	In my laboratory sessions, the teacher decides the best way for me to carry out the laboratory experiments.	1	2	3	4	5	R ____
28.	What I do in laboratory sessions helps me to understand the theory covered in regular science classes.	1	2	3	4	5	____
29.	The teacher outlines safety precautions to me before my laboratory sessions commence.	1	2	3	4	5	____
30.	The laboratory is an attractive place for me to work in.	1	2	3	4	5	____
31.	I work cooperatively in laboratory sessions.	1	2	3	4	5	____
32.	I decide the best way to proceed during laboratory experiments.	1	2	3	4	5	____
33.	My laboratory work and regular science class work are unrelated.	1	2	3	4	5	R ____
34.	My laboratory class is run under clearer rules than my other classes.	1	2	3	4	5	____
35.	My laboratory has enough room for individual or group work.	1	2	3	4	5	____

For teacher's use only: SC ____ OE ____ I ____ RC ____ ME ____

SCIENCE LABORATORY ENVIRONMENT INVENTORY (SLEI)

PREFERRED FORM

Directions

This questionnaire contains statements about practices which could take place in this laboratory class. You will be asked **how often** you would **prefer** each practice to take place.

There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

Think about how well each statement describes what your preferred laboratory class is like. Draw a circle around

1	if you would prefer the practice to take place	ALMOST NEVER
2	if you would prefer the practice to take place	SELDOM
3	if you would prefer the practice to take place	SOMETIMES
4	if you would prefer the practice to take place	OFTEN
5	if you would prefer the practice to take place	VERY OFTEN

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

Some statements in this 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 would choose my partners for laboratory experiments." You would need to decide whether you thought that you would prefer to choose your partners *Almost Never, Seldom, Sometimes, Often or Very Often.* For example, if you selected *Very Often*, you would circle the number 5 on your answer sheet.

Code: _____ Gender: Male/Female

	*Remember that you are describing your **preferred** classroom.*	Almost Never	Seldom	Sometimes	Often	Very Often	For Teacher's Use
1.	I would get on well with students in this laboratory class.	1	2	3	4	5	____
2.	There would be opportunity for me to pursue my own science interests in this laboratory class.	1	2	3	4	5	____
3.	What I do in our regular science class would be unrelated to my laboratory work.	1	2	3	4	5	R ____
4.	My laboratory class would have clear rules to guide my activities.	1	2	3	4	5	____
5.	I would find that the laboratory is crowded when I am doing experiments.	1	2	3	4	5	R ____
6.	I would have little chance to get to know other students in this laboratory class.	1	2	3	4	5	R ____
7.	In this laboratory class, I would be required to design my own experiments to solve a given problem.	1	2	3	4	5	____
8.	The laboratory work would be unrelated to the topics I am currently studying in my science class.	1	2	3	4	5	R ____
9.	My laboratory class would be rather informal and few rules are imposed on me.	1	2	3	4	5	R ____
10.	The equipment and materials that I need for laboratory activities would be readily available.	1	2	3	4	5	____
11.	Members of this laboratory class would help me.	1	2	3	4	5	____
12.	In my laboratory sessions, other students would collect different data than I would for the same problem.	1	2	3	4	5	____
13.	My regular science class work would be integrated with laboratory activities.	1	2	3	4	5	____
14.	I would be required to follow certain rules in the laboratory.	1	2	3	4	5	____
15.	I would ashamed of the appearance of this laboratory.	1	2	3	4	5	R ____
16.	I would get to know the students in this laboratory class well.	1	2	3	4	5	____
17.	I would be allowed to go beyond the regular laboratory exercise and do some experimenting of my own.	1	2	3	4	5	____
18.	I would use the theory from my regular science class sessions during laboratory activities.	1	2	3	4	5	____
19.	There would be a recognised way for me to do things safely in the laboratory.	1	2	3	4	5	____
20.	The laboratory equipment which I use would be in poor working order.	1	2	3	4	5	R ____
21.	I would be able to depend on other students for help during laboratory classes.	1	2	3	4	5	____
22.	In my laboratory sessions, I would do different experiments than some of the other students.	1	2	3	4	5	____
23.	The topics covered in regular science class work would be quite different from topics with which I deal in laboratory sessions.	1	2	3	4	5	R ____
24.	There would be few fixed rules for me to follow in laboratory sessions.	1	2	3	4	5	R ____
25.	I would find that the laboratory is hot and stuffy.	1	2	3	4	5	R ____
26.	It would take me a long time to get to know everybody by his/her first name in this laboratory class.	1	2	3	4	5	R ____
27.	In my laboratory sessions, the teacher would decide the best way for me to carry out the laboratory experiments.	1	2	3	4	5	R ____
28.	What I do in laboratory sessions would help me to understand the theory covered in regular science classes.	1	2	3	4	5	____
29.	The teacher would outline safety precautions to me before my laboratory sessions commence.	1	2	3	4	5	____
30.	The laboratory would be an attractive place for me to work in.	1	2	3	4	5	____
31.	I would work cooperatively in laboratory sessions.	1	2	3	4	5	____
32.	I would decide the best way to proceed during laboratory experiments.	1	2	3	4	5	____
33.	My laboratory work and regular science class work would be unrelated.	1	2	3	4	5	R ____
34.	My laboratory class would be run under clearer rules than my other classes.	1	2	3	4	5	____
35.	My laboratory would have enough room for individual or group work.	1	2	3	4	5	____

For teacher's use only: SC ____ OE ____ I ____ RC ____ ME ____

APPENDIX C ATTITUDE TO THIS CLASS QUESTIONNAIRE

ATTITUDE TO THIS CLASS

Code: _____

Items 1-7 below consist of a number of statements about the class which you are in right now. You will be asked what you think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

For each statement, draw a circle around

SA	if you STRONGLY AGREE with the statement;
A	if you AGREE with the statement;
N	if you are NOT SURE;
D	if you DISAGREE with the statement;
SD	if you STRONGLY DISAGREE with the statement.

1.	I look forward to this class.	SA	A	N	D	SD
2.	I feel confused during this class.	SA	A	N	D	SD
3.	This class is a waste of time.	SA	A	N	D	SD
4.	This class is among the most interesting at this school.	SA	A	N	D	SD
5.	The work is hard in this class.	SA	A	N	D	SD
6.	The thought of this class makes me tense.	SA	A	N	D	SD
7.	I enjoy this class.	SA	A	N	D	SD