Science and Mathematics Education Centre

Teacher Interpersonal Behaviour: Its Influence on Student Motivation, Self-Efficacy and Attitude Towards Science

Catherine Anne Reid

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ABSTRACT

The effect that teacher interpersonal behaviour has on motivating students to want to learn and on nurturing student self-efficacy in the science classroom cannot be underestimated. Teacher interpersonal behaviour can be perceived to be the catalyst that determines the level of student self-efficacy in classroom activities. An analysis of effective classroom teaching has been assessed in recent times in relation to teacher interpersonal behaviour. However, the effect that teacher interpersonal behaviour has on student motivation has not been studied.

The aim of this study was to identify the interpersonal skills of teachers that are perceived to encourage a motivating classroom environment. It also described students' perceptions of teacher interpersonal behaviour and classroom environment, and assessed the significant impact teacher interpersonal behaviour had on student self-efficacy and student attitude towards science. Student data were collected from 313 year 8, 9 and 10 science students in 12 classrooms in a girls' secondary school in Brisbane, Australia. They were studying a general science course that covered aspects of biology, chemistry and physics. Qualitative and quantitative data were collected. The study confirmed the validity and reliability of the *Questionnaire on Teacher Interaction* (QTI) and the *Students' Motivation, Attitude and Self-Efficacy in Science* (SMASES) questionnaire. Thus, the study identified perceptions of teacher interpersonal behaviour and classroom environment, and investigated associations between the results obtained from the analysis and the other instruments that were administered in the study. The study identified that there was a significant relationship between teacher interpersonal behaviour and its effect on student motivation, self-efficacy and attitude towards science.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AEQ	Attitude and Efficacy Questionnaire
ATBS	Attitudes Toward Biology Scale
BSES	Biology Self-Efficacy Scale
CAEQ	Chemistry Attitudes and Experiences Questionnaire
CAS	Computer Attitude Scale
CCQ	Classroom Climate Questionnaire
CES	Classroom Environment Scale
CLASS	Colorado Learning Attitudes about Science Survey
CLASSS	Classroom Learning Atmosphere Scale for Secondary Schools
CLEI	Chemistry Laboratory Environment Inventory
CLES	Constructivist Learning Environment Survey
CSCES	College Science Classroom Environment Survey
CUCEI	College and University Classroom Environment Inventory
DOL	Dimensions of Learning
ENJ	Enjoyment of Science Lessons
ESLEI	Environmental Science Learning Environment Inventory
GSES	General Self-Efficacy Scale
ICEQ	Individualised Classroom Environment Questionnaire
ICL	Interpersonal Adjective Checklist
ILEQ	Instructional Learning Environment Questionnaire
KMLCQ	Kieler Motivational Learning Climate Questionnaire
LEI	Learning Environment Inventory
LPSS	Learning Preference Scale for Students
LPST	Learning Preference Scale for Teachers
MBTI	Myers-Briggs Type Indicator
MCI	My Class Inventory
MITB	Model for Teacher Interpersonal Behaviour
MJSES	Morgan and Jinks Self-Efficacy Scale
MMI	Multidimensional Motivational Instrument
MSAA	Minnesota School Affect Assessment
MSC	My Science Class

MSLQ	Motivated Strategies for Learning Questionnaire
MTAI	Minnesota Teacher Attitude Inventory
OSES	Occupational Self-Efficacy Scale
PALS	Patterns of Adaptive Learning Scales
PCAQ	Perceptions of the Curriculum in Action Questionnaire
PCE	Primary Certificate Examinations
PEEL	Project for Enhancing Effective Learning
PIQ	Principal Interaction Questionnaire
QTI	Questionnaire on Teacher Interaction
QTIE	Questionnaire on Teacher Interaction Elementary
SAAS-R	School Attitude Assessment Survey - Revised
SAI II	Science Attitude Instrument
SAQ	Science Attitude Questionnaire
SCES	Science Classroom Environment Survey
SLEI	Science Laboratory Environment Inventory
SLEQ	School Level Environment Questionnaire
SMASES	Students' Motivation, Attitude and Self-Efficacy in Science
SMTSL	Students' Motivation Toward Science Learning
SPTA	Students' Perceptions Toward Assessment
S.OR.T	Scientific Orientation Test
SSEP	Summer Science Exploration Program
SSEQ	Science Self-Efficacy Questionnaire
SSES	Student Self-Efficacy Scale
STEBI-A	Science Teaching Efficacy Belief Instrument-A
STEBI-B	Science Teaching Efficacy Belief Instrument-B
TCBQ	Teacher Communication Behaviour Questionnaire
TES	Teacher Efficacy Scale
TOES	Test of Enquiry Skills
TOSEA	Teacher Self and Organizational Efficacy Assessment
TOSRA	Test of Science-Related Attitudes
TROFLEI	Technology-Rich, Outcomes-Focussed Learning Environment Inventory

TSSE	Test of Science Self-Efficacy
WASP	Wareing Attitude toward Science Protocol
WIHIC	What is Happening In This Class?

CHAPTER 1

INTRODUCTION

This study involved an investigation of the effect that teacher interpersonal behaviour has on student self-efficacy, motivation and attitude towards science in junior science classrooms in Australian private schools. Classroom environment has been assessed in a variety of ways and on a regular basis (Fisher & Fraser, 1983; Fisher & Kent, 1998; Fraser, 1986; Fraser, 1991; Fraser, 1994; Fraser & Walberg, 1991; Moos, 1979; Moos & Trickett, 1974; Rawnsley & Fisher, 1997). Similarly, self-efficacy has been widely studied, in order to ascertain its relevance in academic motivation (Hackett & Betz, 1989; Schunk, 1981; Schunk, 1982; Schunk, 1983; Schunk, 1989; Stiggins, 1999; Zimmerman, Bandura, & Martinez-Pons, 1992). However, this research is unique, in that it seeks to address how influential teacher interpersonal behaviour can be in determining the level of student self-efficacy in the science classroom. It is also the first time that the questionnaire on student motivation regarding the learning of science has been used in Australia. The study provides ideas for initiating change, so that the classroom environment becomes more conducive to motivated learning. It also identifies what specific factors of teacher interpersonal behaviour influence students' fluctuating levels of self-efficacy in and their enjoyment of science.

1.1 BACKGROUND TO THE STUDY

It is the teacher's role to ensure that an inviting classroom environment should enhance productive and enjoyable learning experiences. Research suggests that teachers are not only instructors but motivators (Brekelmans, Levy, & Rodriguez, 1993; Brekelmans, Wubbels, & Levy, 1993; Créton, Wubbels, & Hooymayers, 1993; De Charms, 1976; Gage & Berliner, 1979; Hargreaves, 1975; Hofstein & Kempa, 1985; Osborne, 1997; Poliakoff, 1998; Rennie, 1990; Rinne, 1998; Walberg, 1991; Wubbels, Créton, & Hermans, 1993). Teachers must exude a genuine amount of enthusiasm for a topic that they are endeavouring to teach if a motivated classroom environment is to be established. Studies in relation to motivation in education include (Ames, 1992; Bernard, 1992; Covington, 1984; Damico & Roth, 1994; Deci & Ryan, 1985; Elton, 1996; Hofstein & Kempa, 1985; Maehr & Midgley, 1991; McCombs, 1994; Trumper, 1995). The ability to generate a warm classroom environment and develop empathy with students are qualities to which all teachers should aspire.

Within any school community, teachers' communication skills and interpersonal skills can have a significant influence on classroom environment, the efforts that students exert on set tasks and the belief that students have in their own ability (Bhushan, 1991; Chidolue, 1996; Créton, Wubbels, & Hooymayers, 1993; Fraser & Walberg, 1991; Hargreaves, 1975; Novak & Gowin, 1984; Rennie, 1990; Wubbels, Brekelmans, & Hooymayers, 1991). This study encourages teachers to reflect on their teaching manner and practices, and may encourage them to adopt interpersonal skills that encourage high levels of student self-efficacy.

The fact that students respond to and perform more effectively for particular teachers has prompted research into assessing classroom environment. To date, there has been no research that identifies the importance of teacher interpersonal behaviour and its effect on student self-efficacy. There has, however, been extensive research on self-efficacy in relation to various other aspects of education. Bandura (1977, 1982, 1986, 1997) is recognized as one of the most widely referred to theorists in relation to self-efficacy. His research focused on how one's level of belief about ability can determine the level of achievement experienced on a set task. Bandura (1986) stated 'what people think, believe and feel affects how they behave' (p. 25).

Numerous educational research studies have highlighted the significant role that self-efficacy plays in academic achievement (Pajares, 1996; Pajares & Schunk, 2001). In the area of academic motivation, self-efficacy beliefs have been investigated thoroughly (Jinks & Morgan, 1996; Jinks & Morgan, 1999; Morgan & Jinks 1994; Pintrich & De Groot, 1990; Pintrich & Schunk, 1995; Schunk, 1989; Schunk, 1995). Pajares (1996) reflected on Bandura's findings and stipulated that well-directed research into self-efficacy must involve complementing quantitative analysis with qualitative research. He also focused on examining self-efficacy beliefs in academic settings. Jinks, Lorsbach, and Morey (2001) also addressed the issue of self-efficacy in relation to its implication for science teachers.

Teachers undeniably have an important role in promoting a warm classroom environment that promotes enjoyable learning and a high level of student self-belief. ‘The behaviour of the teacher is influenced by the behaviour of the students and in turn, influences student behaviour’ (Fisher, Henderson, & Fraser, 1995, p. 125). Schunk’s work (1981, 1982, 1983) revealed that having high self-efficacy beliefs sustains task involvement and lower self-efficacy leads to less perseverance that lowers achievement. Although there has been extensive research in recent years regarding teacher interpersonal behaviour, there has been no connection made between teacher behaviour and the effect it has on student self-belief. However, it is of some concern that students perform well for some teachers and not others. The level of self-belief that students acquire in the classroom, could well influence the level of commitment they are willing to exert on set tasks. This study has addressed such an issue. It aimed to identify whether particular types of teachers had a greater influence on promoting and sustaining student self-efficacy. Bandura (1997) suggested that knowledge and skill are often poor predictors of performance, and that it is self-belief that ultimately determines how one executes a certain task. It is with this thought in mind, that teacher interpersonal behaviour could be viewed as having some degree of influence on the level students’ self-belief.

Self-efficacy refers to the level of confidence that one possesses to perform a set task. Bandura (1977, 1986) viewed self-efficacy as belief about ability that determines performance, the belief in one’s ability to organize and execute actions required to manage prospective situations. A variety of clinical issues have also been researched using self-efficacy, including phobias (Bandura, 1983); depression (Davis & Yates, 1982); smoking behaviour (Garcia, Schmitz, & Doerfler, 1990); heart attacks (Ewart, 1995) and pain control (Manning & Wright, 1983). Other research topics that have benefited from investigating self-efficacy include career choice (Hackett & Betz, 1995) and mathematical problems (Hackett & Betz, 1989).

Classroom environment studies have been of interest for decades, many studies occurring in the 1980s or earlier. The classroom environment is created by students and teachers in which students perceive ‘the nature and purposes of learning’ (Ames, 1992, p. 261). Researchers have focused on developing, applying and validating instruments that effectively analyze learning environments (Fraser, 1986; Fraser, 1991; Fraser, 1994; Fraser & Walberg, 1991). Copious amounts of research have ensured that the numerous questionnaires that have been developed are pertinent, valid, and invaluable to studies involving learning environments. Instruments include the *Classroom Environment Scale* (CES) (Moos & Trickett, 1974), the *What is Happening In This Class?* (WIHIC) (Fraser, Fisher, & McRobbie, 1996), the *Individualised Classroom Environment Questionnaire* (ICEQ) (Fraser, 1990) and the *Constructivist Learning Environment Survey* (CLES) (Taylor, Fraser, & White, 1994), together became the *Science Classroom Environment Survey* (SCES). The *Science Laboratory Environment Inventory* (SLEI) (Fraser, Giddings, & McRobbie, 1992a) is another valuable tool that was developed to monitor the effectiveness that laboratory work has on students’ attitudes toward science.

Research has shown that teacher interpersonal behaviour is an important aspect of the classroom environment. Well-documented research in the area of interpersonal behaviour has contributed to significant developments in the construction of the *Questionnaire on Teacher Interaction* (QTI) that reliably assesses teacher interpersonal behaviour. The QTI has been utilized in a variety of settings (Fisher, Fraser, & Rickards, 1996; Fisher, Fraser, & Wubbels, 1993; Fisher, Henderson, & Fraser, 1995; Fisher, Rickards, Goh, & Wong, 1997; Fraser & Goh, 1996; Wubbels, 1993; Wubbels, Brekelmans, & Hooymayers, 1991; Wubbels, Créton, Levy, & Hooymayers, 1993; Wubbels & Levy, 1991).

Extensive research in Australia and overseas has encouraged researchers to continue to pursue a greater understanding of factors that influence classroom environment and teacher interpersonal behaviour. The domain of self-efficacy is an avenue of research that is extensive and potentially useful when analyzing influences on classroom environment. This unique research provides avenues for teachers to reflect on their interpersonal behaviour and determine if such behaviour influenced student self-efficacy, a comparison that has not be considered in relation to classroom environment until now. A study of this nature, therefore, has the capacity to evaluate staff interpersonal behaviour and presents opportunities for initiating change, so that the classroom environment becomes more conducive to enhancing student motivation and self-efficacy in science education.

1.2 OBJECTIVES

This research specifically addressed the issues of student self-efficacy, motivation, enjoyment of science in relation to teacher interpersonal behaviour. Teacher interpersonal behaviour was assessed in relation to its effect on student self-efficacy, its influence on student motivation for learning science and the level of enjoyment of students' experiences in the science classroom. That is, regardless of academic ability, the question to contemplate is, how critical is the teacher's interpersonal behaviour on heightening students' self-efficacy, motivation and encouraging them to want to learn.

The objectives of this research that were derived from this question are:

1. To identify teaching strategies that students believe motivate them to want to learn science.
2. To validate the *Students' Motivation, Attitude and Self-Efficacy in Science* (SMASES) for use in Australian schools.
3. To investigate associations between:
    - students' perceptions of their teacher's interpersonal behaviour and their motivation in science;
    - students' perceptions of their teacher's interpersonal behaviour and their feelings of self-efficacy in science;
    - students' perceptions of the teacher's interpersonal behaviour and their attitude towards science lessons;
    - students' motivation in science and their attitude towards science lessons; and
    - students' motivation and their feelings of self-efficacy in science lessons.

1.3 RESEARCH QUESTIONS

The pertinent questions that evolved from my preliminary research were constructed under the assumption that students' efforts in the classroom may be a direct result of their perception of teacher interpersonal behaviour and their own self-efficacy beliefs, and not necessarily an indication of their academic ability. Thus, it became necessary to pose questions that sought to gather information about students' receptiveness to certain types of teachers and teaching methods, irrespective of the students' academic ability. The study is not designed to investigate achievement levels of students involved in the study, merely the influence that teacher interpersonal behaviour has on students' enthusiasm to acquire knowledge and whether or not they believe that their level of self-efficacy is determined within the classroom.

Therefore, the first research question to be addressed was:

Question 1: Are the QTI, SMASES questionnaires reliable and valid for assessing teacher interpersonal behaviour, student self-efficacy, student motivation and enjoyment of science in Queensland Private Schools?

The central focus in this study is to investigate possible links between student motivation, student attitude, student self-efficacy and teacher interpersonal behaviour in junior science classrooms. Thus, students' perceptions of these three factors will be identified using the SMASES questionnaire. Their responses in relation to the influence that they believe teacher interpersonal behaviour has in the classroom in will be analyzed using the QTI.

Question 2: What associations are there between students' perceptions of their teacher's interpersonal behaviour and their motivation in science?

The QTI and the SMASES have not been used in conjunction with each other in junior science classrooms before this study.

Question 3: Are students' self-efficacy levels determined by a particular 'type' of teacher, as identified by the QTI?

Prior research has indicated that students are more likely to be more industrious and spontaneous in a classroom environment that embraces their learning needs. As previously mentioned, Schunk (1981, 1982, 1983) asserts that the level of self-efficacy beliefs influences task involvement. With this in mind, a variety of teaching strategies should be implemented into the classroom to encourage an enthusiastic and productive learning environment. The next four questions sought to address this issue:

Question 4: What teaching strategies, as identified by students, are used by teachers who are able to enhance student motivation in science?

Question 5: What associations are there between students' perceptions of teacher interpersonal behaviour and their enjoyment of science?

Question 6: What associations are there between students' motivation in science and their enjoyment of science?

Question 7: What associations are there between students' motivation and their self-efficacy in science?

1.4 SIGNIFICANCE OF THE STUDY

This study provides a considerable addition to the work already conducted on teacher interpersonal behaviour and classroom environment. The use of the QTI provides further evidence of its effectiveness and validity. Its usefulness as a comparative tool in the area of student self-efficacy using the SMASES was also analysed. This study was particularly unique, in that it utilized an instrument that seeks to identify student self-efficacy and to explain the associations between this and the importance that students place on teacher interpersonal behaviour in science classrooms. This study prompted teachers to recognize, nurture and cater for varying levels of student self-efficacy, attitude and motivation, to recognize how students respond to a particular teacher type and ultimately create a better classroom environment.

The validity and reliability of the QTI and the SMASES was confirmed during this study. The SMASES was validated for the first time in Australian schools. The usefulness of the QTI was portrayed as an important instrument for identifying students' views on the effectiveness of teachers in the science classroom. That is, this study identified whether a particular 'type' of teacher had greater influence in enhancing students' self-efficacy and creating a positive, motivated and enjoyable classroom environment.

Another distinctive aspect of this research is the extensive use of qualitative and quantitative data. Combining these research methods enables a more thorough analysis of both forms of data (Fraser & Tobin, 1991, Shulman, 1988) and portrays more detailed evidence of the findings. It is the intention of this research that the findings will prompt teachers to reassess their views on learning. Advice regarding teacher type and avenues that seek to enhance student self-efficacy will be provided to schools that are seeking to provide an enjoyable learning environment for their science students.

1.5 METHODOLOGY OVERVIEW

Firstly, this research entailed administering the QTI to students in 12 junior science classrooms (years 8, 9 & 10) in one private girls' school in Brisbane. The sample size was 313 and the students were between 12 and 15 years of age. These students completed the 48-item, eight-scale QTI (Wubbels, 1993) to determine students' perceptions of teacher-student interpersonal behaviour. Student motivation, attitude towards science and self-efficacy was measured by using the SMASES.

The quantitative data were statistically analysed and described in detail in Chapters 6 and 7 and then affiliations were sought from the qualitative data in Chapter 8. A number of students were interviewed with the intention of gathering a more detailed account of their interpretation of the atmosphere within the classroom. Quantitative analysis alone does not allow for such interpretation. Batten (1993) stressed the importance of reporting on exact phraseology if the conclusions drawn from interviews are to be respected and valid. This approach to the research ensured that the data presented had greater reliability and provide a more profound understanding of students' perceptions of classroom environment.

Wubbels (1993) observed that the teachers' impression of their own behaviour and the students' perception of the teacher's behaviour can differ significantly. It was with this idea in mind, that it was important to interview a sub-sample of students from the school. This provided salient information concerning their views on interpersonal behaviour and classroom environment. The qualitative data were examined and collated into concise summaries to gain a general overview of the major research questions. The analysis of the qualitative data enabled a more thorough understanding of the quantitative data.

1.6 THESIS OVERVIEW

Overall, this study will prove to be significant for researchers who are interested in examining the associations between the QTI and the SMASES. The fact that qualitative measures are used in conjunction with quantitative analysis suggests that the conclusions drawn will be of immeasurable benefit to education researchers and teachers (Fraser, 1996). This study reveals features of the ideal classroom environment and teacher interpersonal behaviour and determines their influence on student self-efficacy, student motivation and enjoyment of science. This chapter describes the context of the study and communicates relevant background information. It presents a brief overview of the methodology and explains the significance of this particular piece of research in education.

Chapter 2 incorporates an extensive literature review that assists in presenting the theoretical framework of this study. Here, the development of the QTI is investigated and previous research using the QTI overseas and in Australia is acknowledged. A vast overview of significant instruments used to measure classroom environment is also detailed in Chapter 2. The theory, reliability and validity of various questionnaires are presented as a concise overview of the pertinent research conducted over some thirty years. A theoretical overview of studies that have investigated student, motivation and attitude to science are forwarded in Chapter 3. Chapter 4 highlights the impact that student self-efficacy plays in determining students' ability to learn and engage themselves in set tasks. Chapter 5 details the methodology adopted in this study. The instrument selection, sample size, data collection and the qualitative and quantitative analysis are described in detail. The validation of the QTI and the SMASES for use in junior science classrooms will prove to be invaluable in comparing these two instruments. Associations between the two instruments used, the QTI the SMASES, are summarized statistically and assist in answering the research questions posed in Chapter 1.

Chapter 6 presents the salient statistical analysis that assisted with validating the QTI and the SMASES for their use in junior science classrooms. Further analysis of teacher interpersonal behaviour, student self-efficacy, student motivation and attitudes towards the learning of science are revealed in Chapter 7. Teacher typology and associations with prominent studies that assisted in recognizing the usefulness of this research were acknowledged. Chapter 8 exposes details collected via the qualitative data where a thorough analysis and interpretation of interview material is presented in an attempt to gain a better understanding of the quantitative results.

Chapter 9 presents a reflection of the researcher's experience of teaching junior science. It is an attempt to portray the researcher's own experience in relation to student self-efficacy, the researcher's interpersonal behaviour, classroom environment, student motivation and students' attitudes towards science. It also summarizes the major findings of the study and provides answers to the research questions. This chapter also presents limitations of this particular study and also includes recommendations for further research in this area of interest.

CHAPTER 2

LITERATURE REVIEW: THE QUESTIONNAIRE ON TEACHER INTERPERSONAL BEHAVIOUR AND CLASSROOM ENVIRONMENT INSTRUMENTS

2.1 INTRODUCTION

The main aim of this study was to ascertain whether teacher interpersonal behaviour influences student self-efficacy, motivation and enjoyment in junior science classrooms in Australian private schools. The issue is initially addressed in this chapter, by presenting the theoretical framework on which research on teacher interpersonal behaviour and classroom management has been founded. Here, the development of various instruments, in particular, the Questionnaire on Teacher Interaction (QTI) and previous research using the QTI overseas and in Australia is presented. Thus, the historical relevance and the impact that classroom environment research has had on science education are discussed in some detail. Quantitative analysis of these instruments is presented, that confirms the validity and suitability for their use in a variety of classroom contexts.

It was the intent of this study to examine if students are motivated as a result of the interpersonal behaviour demonstrated by certain teachers. An enjoyable classroom environment certainly contributes to students experiencing a sense of self-worth and developing and eagerness to succeed. Various teaching strategies have the capacity to enhance student participation, but research suggests that teacher interpersonal behaviour can prove to be equally important in influencing students to want to learn.

Hargreaves (1975) stated that ‘it is the teacher, then, who is the principal creator of the climate that prevails in the classroom; the pupils’ response is largely determined by the teacher’s behaviour’ (p. 116). There is also a belief that the classroom environment is the product of the types of interactions that teachers develop with students (Tonelson, 1981). Khine and Fisher (2002) stated that ‘teacher-student interaction has become a potentially powerful determinant of student learning' (p. 14). They also stipulated that teachers should develop a good rapport with students and attempt to not only create but maintain a favourable and positive classroom learning environment.

Overall, this chapter provides crucial evidence that supports the reputable research into classroom environments and specifically teacher interpersonal behaviour. The section that follows addresses pertinent research in the field of classroom environments.

2.2 CLASSROOM ENVIRONMENT RESEARCH

Fraser (1993) identified the importance that classroom environment assessments have had on linking student achievement and attitudes, and in providing teachers with guidelines to improve their classroom performance. Herbert Walberg and Rudolf Moos were responsible for initiating classroom environment research more than 30 years ago (Fraser, 1986, 1989, 1992). Walberg commenced his research by assessing activities associated with the Harvard Physics Project (Anderson & Walberg, 1968; Walberg, 1968a, 1968b; Walberg & Anderson, 1968; Welch & Walberg, 1972) thus, instigating early research on the *Learning Environment Inventory* (LEI). Moos' focus on classroom environments stemmed from his work on social climate scales in various settings, including psychiatric hospitals (Moos & Houts, 1968). His research finally culminated in the development of the Classroom Environment Scale (CES) (Moos & Trickett, 1974).

Research in relation to classroom environment has been significantly influenced by work carried out by Lewin (1936), Murray (1938) and Pace and Stern (1958). These pioneers based their findings on theoretical, conceptual and measurement foundations. In particular, Lewin asserted that the environment and its interaction with the personal characteristics of individuals were responsible for human behaviour. His formula $B = f(P,E)$ suggested that human behaviour (B) was dependant on the makeup of the person (P) and the environment (E). Walberg and Moos certainly made valuable contributions to perceptions of classroom environment and their work helped to identify the need for continued research in this area. Chavez

(1984) recognized Walberg's and Moos' work to be greatly 'influenced by prior work involving low inference and direct observational methods of measuring classroom environment' (Fraser & Walberg, 1991, p. 4).

2.2.1 Murray's Needs-Press Model

Murray utilized Lewin's theory, his own theoretical research and thoughts on personal needs and environmental press that gave the foundation for the development of the CES. Murray believed that environmental climate influenced behaviour. His use of Lewin's needs-press model identified personal needs as referring to motivational personality characteristics that influence one's level of approach towards certain goals. Murray (1938) recognized *alpha press* to describe the environment as observed by an external observer and *beta press* to describe the environment as perceived by its inhabitants. Stern, Stein, and Bloom (1956) extend one's understanding of *beta press* to be the private view that the individual holds in relation to the environment; and *alpha press* to be the consensual view that a group develops about the environment.

Classroom environment research in recent years has focused on a variety of issues that are of immense value to those in any education system. Extensive research has resulted in gaining a more comprehensive insight into perceptions of classroom learning environments (Aldridge & Fraser, 2000; Fraser, 1989; Fraser & Fisher, 1994; Fraser, Giddings, & McRobbie, 1992a, 1992b; Fraser & Walberg, 1991; Henderson & Reid, 2000; Huffman, Lawrenz, & Minger, 1997; Nair & Fisher, 2000) and teacher interpersonal behaviour in the classroom (Fisher & Rickards, 2000; Kent & Fisher, 1997; Scott & Fisher, 2000; Wubbels, 1993; Wubbels, Brekelmans, & Hooymayers, 1993; Wubbels, Créton, Levy, & Hooymayers, 1993). Thus, classroom environment research is well established and the utilization of the QTI to support such valuable findings has already been identified in this study.

There are numerous classroom environment instruments available that adequately assess perceptions of classroom learning. The *Learning Environment Inventory* (LEI), Classroom Environment Scale (CES), Individualised Classroom Environment Questionnaire (ICEQ), *My Class Inventory* (MCI), *College and University*

Classroom Environment Inventory (CUCEI), and the Science Laboratory Environment Inventory (SLEI) are the most frequently used instruments that have been utilized in Australia. Table 2.1 identifies the name of each scale contained in each instrument, the level of suitability of each instrument, the number of items in each scale and in particular, Moos' (1974) scheme for classifying human environments. Moos identified three basic types of dimension that assist in explaining characteristics of human behaviour. The *Relationship Dimension* that assesses the nature and intensity of relationships; the *Personal Development Dimension* that assesses the extent of personal growth and self-enhancement and the *System Maintenance and System Change Dimension* that assesses the responsiveness, orderliness, level of expectation and control in the environment. Over 30 years has been spent developing instruments that assess classroom learning environments. The classroom environment instruments that are outlined below illustrate significant contributions to science classroom research that have been achieved in recent times.

2.2.2 Classroom Environment Questionnaires

Learning Environment Inventory (LEI)

The Learning Environment Inventory (LEI) was devised in the 1960s (Fraser, Anderson, & Walberg, 1982) and was designed to measure the actual learning environment. It is an instrument that was created from improvements made to the *Classroom Climate Questionnaire* (CCQ) (Walberg, 1968a). By 1969, the LEI contained 15 scales that were determined by previously good indicators of learning. These concepts that were the basis of the scale development, were considered to be extremely relevant to the social psychology of the classroom and the social psychology of theory and research in education. The final version of the LEI contains 105 statements that describe typical school classes. The responses are recorded on a four-point scale of Strongly Disagree to Strongly Agree with some items being scored in the reverse order.

Table 2.1
Overview of Scales Contained in Six Classroom Environment Instruments (LEI, CES, ICEQ, MCI, CUCEI and SLEI)

Instrument	Level	Items Per Scale	Scales Classified According to Moos's Scheme: Relationship Dimensions	Personal Development Dimensions	System Maintenance & Change Dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganization Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order & Organization Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalization Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Elementary	6–9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalization Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualization
Science Laboratory Environment Inventory (SLEI)	Upper Secondary Higher Education	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment

Source: (Fraser, 1991, p. 7)

The LEI has proven to be a well utilized and a particularly useful classroom environment instrument in Australia (Fraser, 1979; Power & Tisher 1975, 1979) and overseas (Hofstein et al, 1979; Lawrenz, 1976; Walberg, 1968a, 1968b, 1972;) for investigating associations between student outcomes and their perceptions of classroom environment. A comprehensive study conducted in Montreal in 1969 involving 1,048 students in 64 grade 10 and 11 classes verified the reliability of the LEI.

The Cronbach alpha coefficients ranged from 0.54 for the Diversity scale to 0.85 for the Goal Direction scale using the individual as the unit of analysis. In another study involving 464 students the Cronbach reliability coefficient ranged from 0.58 to 0.86 for the same two scales, Diversity and Goal Direction. Intraclass correlations were calculated for a sample of 29 classes in 1967 and ranged from 0.43 to 0.84 and in 1969 for a sample of 64 classes values ranged from 0.31 to 0.92. In 1970, the test-retest reliability using the individual as the unit of analysis with 139 students in the USA. ranged from 0.43 to 0.73. The mean correlation of each scale compared to the other 14 scales ranged from 0.08 for Competitiveness and 0.40 for Disorganization. All these results suggest that the LEI scales possess satisfactory reliability.

My Class Inventory (MCI)

The My Class Inventory (MCI) (Fisher & Fraser, 1981; Fraser, Anderson, & Walberg, 1982) is an instrument that stemmed from the development of the LEI. It has been used in Australia (Fraser & O'Brien, 1985) and the USA (Lawrenz, 1988). It is a simplified version of the LEI that is designed to assist primary and junior secondary students to understand the language in the questions. The scales contain only five of the 15 LEI scales, Satisfaction, Friction, Competitiveness, Difficulty and the last block of questions assesses Cohesiveness. The questions posed were reduced from 105 to 38 and the four-point response format became a yes/no response. The short form of the MCI contains 25 items and is available in two forms that measure the actual and the preferred environment. The reliability of the short form of MCI scales was acknowledged in a study conducted in an Australian study consisting of 758 third grade students in 32 classes in Sydney (Fraser & O'Brien, 1985). The actual and the preferred forms were administered to these students and the reliabilities for class means for the actual form ranged from 0.58 to 0.81 and from 0.60 to 0.82 for the preferred form.

An extensive study conducted in Tasmania, involved 2,305 year 7 students (Fraser, Anderson, & Walberg, 1982). The Cronbach reliability, using the individual as the unit of analysis, ranged from 0.62 to 0.78, the mean correlation with other scales ranged from 0.10 for the Competitiveness scale to 0.26 for the Friction scale. The ANOVA eta^2 ($p < 0.01$) that indicates each scale's ability to discriminate between classrooms ranged from 0.18 to 0.31 (Fraser, 1994). The statistical analysis indicates that the MCI is an effective instrument for measuring perceptions of elementary classroom environments. It also has the capacity to be used to assess an actual classroom environment as well as a preferred classroom environment.

Other studies directed at elementary school students include one conducted in Taiwan (Shieh & Tuan, 2000) that investigated 399 students' perceptions of the purpose of assessment. Students from four different year levels completed the *Students' Perceptions Towards Assessment* (SPTA) questionnaire. This study outlined the effect that the type of assessment has on students' learning styles and teachers' teaching styles. Lin (2000) investigated how elementary science teachers can increase student learning. Data was collected from 1,500 students in grade 5 science classrooms in Taiwan and involved a variety of participant observation recording techniques. The students completed the *My Science Class* (MSC) questionnaire (Lin, 1998b) to assess the actual learning environment. In general, this study highlighted teachers' recognition of their need to improve their science teaching practice.

The Classroom Environment Scale (CES)

The development of the Classroom Environment Scale (CES) sought to assess the impact that classroom environment has on learning. It was developed by Rudolf Moos and Edison Trickett (Moos & Trickett, 1987), as a result of Moos' previous work that involved measuring various human environments including extensive research in hospitals, school classrooms and prisons. They identified aspects of the psychosocial environment of classrooms that were important to students and teachers

(Moos, 1979). The CES is often used to assess teacher behaviour, teacher-student interactions and student-student interactions. The CES has had extensive use in high schools in the United States and it is unique in that it can also be used to obtain the observer's impression of the classroom environment. The original version of the CES consisted of 242 items representing 13 conceptual dimensions (Trickett & Moos, 1973). Trials were undertaken in 22 classrooms that resulted in the number of items being reduced to 208. Eventually a 90-item version consisting of nine scales with ten items of True/False was devised and teachers' and students' impressions of classroom environment were constructed.

The CES has been utilized and validated in classroom settings in Australia (Fisher & Fraser, 1983), the USA (Humphrey, 1984; Moos & Moos, 1978; Trickett & Moos, 1973) and in South Africa (Keyser & Barling, 1981). In Australia, Fisher and Fraser (1983) conducted a study that involved 1,083 junior science students from 116 year 8 and 9 science classes. Results from this study also confirmed the use of the CES as a valuable tool for assessing classroom environment. The individual was used as the unit of analysis and reliability values ranged from 0.51 for Competition to 0.75 for Teacher Support. The ANOVA eta^2 statistic ranged from 0.18 to 0.43 ($p<0.01$) and the mean correlation with other scales ranged from 0.09 to 0.40.

Results from an American study involving 465 students (Moos & Trickett, 1974) indicated that the subscale internal consistencies were acceptable and ranged from 0.67 to 0.86. The average item-subscale correlation averaged 0.52 the lowest value being recorded as 0.44 for Competition and the highest, 0.57 for the Involvement scale as well as the Teacher Control scale. There was an average subscale inter-correlation of approximately 0.25 that indicates that the subscales did measure a distinct measure of classroom environment. The overall stability of the CES was investigated using intra-class correlations and the results indicated that the CES showed extremely high profile stability over several weeks.

Individualized Classroom Environment Questionnaire (ICEQ)

The Individualized Classroom Environment Questionnaire (ICEQ) 'differs from other environment scales in that it assesses those dimensions (e.g. Personalization, Participation) which distinguish individualized classrooms from conventional ones' (Fraser & Fisher, 1994, p. 26). Intensive research resulted in the development of the long form ICEQ (Rentoul & Fraser, 1979). Secondary school teachers and junior high school students provided valuable feedback to the researchers that provided avenues for editing scale statistics and ensuring that the dimensions and items of the ICEQ were suited to those completing the questionnaire (Fraser, 1991). The final version of the ICEQ (Fraser, 1990) contained 50 items, ten items belonging to each of the five scales: Personalization, Participation, Independence, Investigation and Differentiation. The questionnaire was answered on a five-point, Likert scale ranging from Almost Never to Very Often with scoring reversed on many items.

A study that validated the use of the 'actual' long form of the ICEQ involved 1,849 Australian students from two states in 150 classes, recorded Cronbach alpha reliability values of 0.68 for the Independence scale to 0.79 for the Personalization scale using the individual as the unit of analysis. Each scale's mean correlation with the other scales ranged from 0.07 for the Independence scale to 0.28 for the Personalization scale. The ANOVA eta^2 ($p<0.01$) statistic values ranged from 0.20 for the Investigation scale to 0.43 for the Differentiation scale (Fraser, 1994). At the class level, the alpha reliability values ranged from 0.77 to 0.91, each scale's mean correlation with other scales ranged from 0.16 to 0.32 (Fraser, 1994). Data collected from a separate study involving 105 Australian students suggested that the test-retest reliability of the actual form of the ICEQ was also satisfactory, with the Cronbach alpha reliabilities ranging from 0.67 for the Participation scale to 0.83 for the Independence scale.

The ICEQ has been cross-validated in Sydney (Fraser & Butts, 1982), and in Indonesia (Fraser, Pearse, & Azmi, 1982). These statistics provide additional support for the use of the ICEQ as a valuable classroom environment tool.

The Science Laboratory Environment Instrument (SLEI)

An extremely valuable instrument called the Science Laboratory Environment Instrument (SLEI) was devised to assess laboratory settings in science classrooms at the secondary school level or in higher education environments (Fraser, Giddings, & McRobbie, 1992a). It assists in examining the effectiveness that laboratory work has on student learning and enjoyment of science. The questionnaire is designed to obtain students' views of their laboratory class environment.

The SLEI includes five scales and the responses include Almost Never, Seldom, Sometimes, Often and Very Often, with the scoring system being reversed in almost half of the items. The initial development of the SLEI was constructed after consideration of five criteria. These included, consideration of the consistency with the literature already developed in relation to laboratory teaching that identified the uniqueness of science laboratory classroom settings; consistency with the classroom environment instruments developed for non-laboratory settings; inclusion of Moos' (1974) categories of dimensions that identify the nature and intensity of personal relationships; the basic direction in which personal growth and self-enhancement occur; the responsiveness of the environment to change; its clarity in relation to expectations; its ability to maintain control and its general order. Thus, an inclusion of Moos' three general categories in the SLEI ensures the adequate assessment of the environment and the relevance of the items in the SLEI from the point of view of teachers and students. Finally, the SLEI proved to be time efficient in relation to answering and scoring. The final version of the SLEI consisted of 35 items in total with seven items in each of the five scales: Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment. Each item was carefully constructed and focus was directed towards making sure that every item was suitable for measuring both the actual and the preferred classroom environment.

The original version (72-item, eight-scale) SLEI was tested and validated in six different countries (the USA, Canada, England, Israel, Australia and Nigeria) sampling a total of 5,447 students from 269 secondary and university classrooms. In order to fine tune the cross-national validation of the SLEI Class form, an interim

(52-item, seven-scale) version was also developed that had satisfactory internal consistency and an acceptable level of scale independence. Fraser (1994) reported that the Cronbach alpha reliabilities for the class actual form and using the individual as the unit of analysis, ranged from 0.70 to 0.83 for the school students and from 0.65 to 0.91 for the university students. Each scale's mean correlation with other scales for the class actual form ranged from 0.07 to 0.37 for the school students and from 0.12 to 0.37 for the university students. The ANOVA eta^2 (p<0.01), which indicates the amount of variance in environment scores accounted for by class membership for the class actual form, ranged from 0.19 to 0.23 for school students and from 0.20 to 0.34 for university students (Fraser, Giddings, & McRobbie, 1992a).

In summary, the dimensions of the SLEI were related positively with student attitudes except for the Open-Endedness dimension. The study highlighted the fact that more favourable student attitudes towards laboratory work were found to be evident in classes where there appeared to be a high level of Student Cohesiveness and Integration. Statistical analysis confirmed that the SLEI has satisfactory reliability for use in any of the six countries, in the actual or preferred form, in schools and universities and using the class mean or the individual as the unit of analysis. Such pertinent research has recognized the SLEI as a useful instrument in assessing its effectiveness in investigating science laboratory classroom environments. It has also been utilized in conjunction with the *Chemistry Laboratory Environment Inventory* (CLEI) in another relevant study conducted overseas (Wong & Fraser, 1994). These studies have also prompted further research into the perceived effectiveness that laboratory work has in secondary schools (Wilkinson & Ward, 1997).

The College and University Classroom Environment Inventory (CUCEI)

The College and University Classroom Environment Inventory (CUCEI) was devised in 1986 to assess classroom environments at the tertiary level, with the specific intent to assess small classes, for example, seminar groups of up to thirty students, and not lectures (Fraser & Treagust, 1986). The construction of the CUCEI involved close examination of the scales and items that comprised the LEI, CES and ICEQ, in order to direct the relevance of the items towards higher education settings. The final form of the CUCEI contains 49 items (seven, seven-item scales) and each item is answered on a four-point scale from Strongly Agree to Strongly Disagree, with the polarity of approximately half of the items being reversed (Fraser, 1991). A study involving 372 students confirmed the validity and reliability of the CUCEI. The Cronbach alpha reliabilities ranged from 0.70 to 0.90, the mean correlation with other scales ranged from 0.34 to 0.47 and the ANOVA eta^2 values were between 0.32 and 0.47 (Fraser, 1994).

A recent study that confirmed the reliability and validity of the CUCEI was conducted by Nair and Fisher (2000). The study endeavoured to develop and validate a personalized form of the CUCEI. It was edited slightly from the original version, in that, it replaced two of the existing scales with two new scales Cooperation and Equity, it was more personalized in its nature and was answered with a five-point Likert Scale. A total of 504 students from 26 classes, 205 from Canadian and 299 from Australian tertiary institutions were involved in the study. Twenty-four instructors also answered the actual and preferred forms of the CUCEI. The Cronbach alpha reliability coefficients using the individual as the unit of analysis, ranged from 0.73 to 0.93 for the actual form and 0.76 to 0.94 for the preferred forms of the CUCEI. Using the class means as the unit of analysis, the reliability values ranged from 0.84 to 0.97 for the actual version and 0.87 to 0.98 for the preferred version. The Cronbach reliability values recorded for the instructors were considered to be good ranging from 0.64 to 0.90 for the actual version and 0.72 to 0.93 for the preferred version. The mean correlation with other scales ranged from 0.15 to 0.38 for the actual version and from 0.25 to 0.47 for the preferred version. The one-way ANOVA using the individual as the unit of analysis suggested that each CUCEI scale differentiated significantly ($p<0.01$) between classrooms (Nair & Fisher, 2000).

2.3 TEACHER INTERPERSONAL BEHAVIOUR: THEORETICAL FRAMEWORK

Much of the work accomplished on teacher interpersonal behaviour stemmed from research that began at the University of Utrecht in The Netherlands in the 1970s. The focus of the *Education for Teachers* project was to target beginning teachers and identify the problems they experienced, with the intention of providing better preservice opportunities for teachers. The most important aspect of this identification period was to focus on teacher behaviour rather than events that contributed to teacher problems, such as workload. Thus, through this research, teacher interpersonal behaviour was identified as the main factor in the discipline problems of beginning teachers. Wubbels and Levy (1993) justified their reasoning for measuring aspects of the learning environment through students' perceptions. Other researchers have gained valuable insights into learning environments by assessing students' perceptions of teacher interpersonal behaviour (Fraser, 1986; Levy, Créton, & Wubbels, 1993).

2.3.1 Systems Theory and Classroom Communication

Initially, systems communication theory was developed in the area of communication processes (Watzlawick, Beavin, & Jackson, 1967). The analysis of interpersonal communication theory in classrooms was adapted by Wubbels, Créton and Holvast (1988). The usefulness of understanding communication systems in the classrooms is unquestionable. The concept of circularity and change infers that there is an interdependent relationship of all aspects in a communication system (Créton, Wubbels, & Hooymayers, 1993). Within the systems perspective on communication, researchers have noted that there are the behaviours of the teacher and the student to consider, as it is assumed that 'behaviours of participants influence each other mutually' (Wubbels, Brekelmans, & Hooymayers, 1991, p. 142).

Doyle (1983) referred to the analysis of teacher-student communication as a process of negotiation. In fact, the circular communication that exists in classrooms, not only consists of behaviour, but, often determines behaviour (Créton, Wubbels, & Hooymayers, 1993). Wubbels and Levy (1993) asserted that effective teaching involves a methodological element, but more importantly relies on interpersonal actions that create and maintain a positive classroom atmosphere. Thus, 'if the quality of classroom environment does not meet certain basic conditions, the methodological aspect loses its significance' (Wubbels & Levy, 1993, p. xiv).

2.3.2 Leary Model

The Leary model of interpersonal behaviour demonstrates that interpersonal behaviour and the way in which one communicates, is determined by the personality of the individual. Leary's clinical work solidified his hypothesis that human behaviour is driven by one's desire to reduce fear and to maintain self-esteem. When communicating, a conscious or unconscious avoidance of anxiety enables people to feel good about themselves. Leary's model specifically dealt with issues regarding clinical psychology and has proven to be a worthwhile tool for investigating interpersonal behaviour using the two dimensions of influence and proximity.

The extensive research developed by Leary provided a better understanding of interpersonal behaviour. This was due to the fact that the model that he developed was able to be utilized inside or outside a clinical setting. The initial beneficial use became apparent when analyzing patient-therapist dialogues and group discussions in clinical and other situations. He and his co-workers were able to distinguish 16 categories of interpersonal behaviour that were later reduced to 8 (Wubbels, Créton, Levy, & Hooymayers, 1993). Leary (1957) mapped these findings onto a two-dimensional plane (Figure 2.1).

One axis was labeled Proximity and this dimension identified the degree of closeness or cooperation between those who are communicating. Leary referred to this continuum as the 'Affection-Hostility' axis. The Influence dimension indicates who is directing the communication and the frequency of such control of the communication. Leary specified that this continuum be known as the 'Dominance-Submission' axis. Although the Proximity and Influence dimensions have been referred to by other names by various researchers (Brown, 1965; Dunkin & Biddle, 1974), they have contributed widely to the analysis of human interpersonal behaviour. The Leary model has been validated in numerous psychological research settings.

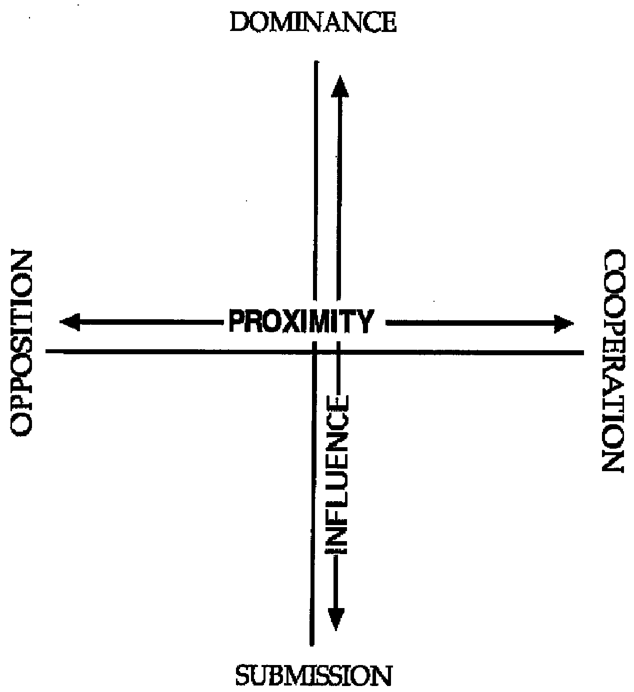

Figure 2.1. The Coordinate System of the Leary Model.
(Wubbels & Levy, 1993, p.15)

2.4 THE DEVELOPMENT OF THE QUESTIONNAIRE ON TEACHER INTERACTION (QTI)

The Leary model was adaptable to classroom situations, however, an instrument that would more closely monitor interpersonal behaviour was developed in the early 1980s. The Questionnaire on Teacher Interaction (QTI) was developed from Leary's *Interpersonal Adjective Checklist* (ICL) in the context of the Leary model and the model on systems communication. The ICL proved to be inadequate due to inappropriate wording of the items when referring to teachers and students (Wubbels, Créton, Levy, & Hooymayers, 1993). Some students found that many of the descriptors did not apply to their teachers at all and their answers were restricted by the lack of elaboration catered for by the 'yes' or 'no' responses. This 128-item instrument was time-consuming to complete and this feedback led to the construction of the QTI. The ICL was refined, by replacing the 'yes' or 'no' response options with a five-point Likert-type scale that used 'never' to 'always' as response alternatives.

The QTI applies the same dimensions as the Leary model, that is, the Influence dimension on the vertical axis and the Proximity dimension of the horizontal axis. However, minor changes in relation to the Proximity dimension continuum occurred. The ‘Affection-Hostility’ continuum was labeled ‘Cooperation-Opposition’ for the QTI (Wubbels, Créton, Levy, & Hooymayers, 1993). The coordinate system for the QTI is illustrated in Figure 2.1.

The original version of the QTI that was developed in the early 1980s in the Netherlands had 77-items (Wubbels, Créton, & Hooymayers, 1985). This Dutch version was completed after four trial runs (Wubbels, Créton, Levy, & Hooymayers, 1993). Wubbels and Levy (1991) reported acceptable internal consistency reliabilities for the QTI scales ranging from 0.76 to 0.84 for student responses and from 0.74 to 0.84 for teacher responses. An American version was developed that contained 64-items (Wubbels & Levy, 1991) confirmed the cross-cultural validity and usefulness of the QTI. Several studies of the reliability and validity of the QTI have been implemented using the Dutch samples (Wubbels, Brekelmans, & Hermans, 1987) and in an American sample (Wubbels & Levy, 1989). The internal consistency reliabilities using the Cronbach alpha coefficient were recorded as good, measuring 0.70 at the student level and usually 0.90 at the class level (Wubbels, Brekelmans, & Hooymayers, 1991). Thus, the QTI can reliably present feedback to teachers about their interpersonal behaviour on the basis of class means. Test–retest reliabilities were recorded at above 0.80. It is important to note, that the Cronbach alpha reliability coefficient in a class (with the students used as items) measures the agreement between students about their perception of the teacher behaviour (Wubbels, Brekelmans, & Hooymayers, 1991). Researchers suggest that at least ten students must complete the QTI for the results to be considered reliable (Wubbels, Créton, Levy, & Hooymayers, 1993).

The Australian version developed by Wubbels (1993) was used in this study. This 48-item short form of the QTI has six items for every sector of the model for teacher interpersonal behaviour. Each of the eight sectors describes a particular behaviour type. They are labeled according to their position in the coordinate system as depicted in Figure 2.2. The respondents complete the questionnaire using the five-point Likert-type scale that ranges from 0 (Never) to 4 (Always). The total score is obtained by adding the totals of the circled numbers for the six items that belong to a particular scale (Wubbels, 1993; Wubbels, Créton, Levy, & Hooymayers, 1993).

There are eight sectors that describe eight different behaviour aspects: DC (Leadership), CD (Helping/Friendly), CS (Understanding), SC (Student Responsibility/Freedom), SO (Uncertain), OS (Dissatisfied), OD (Admonishing) and DO (Strict). The sectors are labeled depending on which aspect of the behaviour is more pronounced. For example, The CD and the DC sectors encompass Cooperation and Dominance. However, in the CD sector, it is evident that there is a more cooperative behaviour functioning than in a DC sector where a more dominant behaviour is characterized. This circumplex model predicts that correlations between two adjacent scales are expected to be highest, but correlations gradually decrease as the scales move further apart until opposite scales are negatively correlated (Khine & Fisher, 2002).

Wubbels, Brekelmans and Hooymayers (1991) noted that ‘every instance of interpersonal teacher behaviour can be placed within the system of axes. The closer the instances of behaviour are in the chart, the more closely they resemble each other’ (p. 142). For every completed questionnaire, a set of eight scores (called a profile) can be produced. The results of administering the QTI also can be represented in a figure, where the degree of the shaded sector relates to the height of the scale scores (Wubbels, Brekelmans, & Hooymayers, 1993).

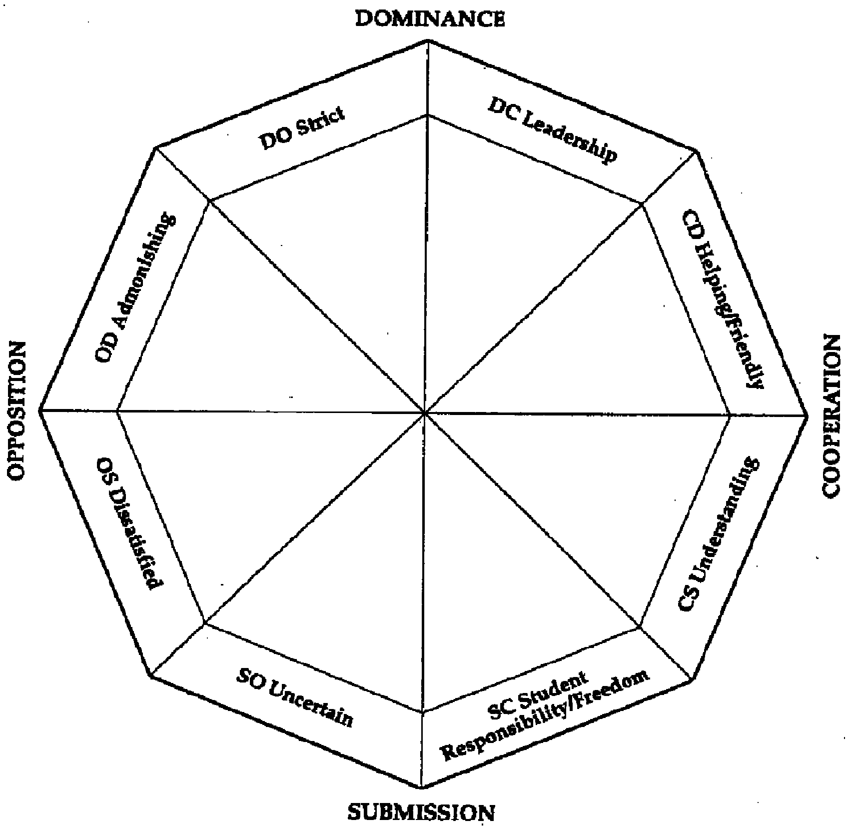

Figure 2.2. The Model for Teacher Interpersonal Behaviour. (Wubbels & Levy, 1993).

2.5 REVIEW OF RESEARCH USING THE QTI

The QTI has been found to be valid and reliable in The Netherlands (Wubbels, Créton, & Hooymayers, 1985), the USA (Wubbels & Levy, 1991) and Australia (Wubbels, 1993). This review is presented in two sections. Firstly, recent overseas studies that have proven the reliability and the extensive use of the QTI, then an overview of pertinent studies that have been carried out in Australian settings.

2.5.1 Overseas Studies

Wubbels (1993) administered the QTI in a study in The Netherlands that involved 66 year 9 Physics classes totalling 1,105 students. Relations between teacher interpersonal behaviour and student achievement and attitudes in the Dutch option of the Second International Science Study were investigated. Student achievement was measured using a 23-item standardized and internationally developed test of physics subject matter. Attitudes were analyzed with questionnaire items that identified students' experience of and motivation for physics lessons. In general, the study identified that, students' perceptions of interpersonal teacher behaviour accounted for a large amount of difference in outcomes between classes of the same ability level.

The study also revealed that the Cooperation scales SC, CS, CD and DC of the model of interpersonal teacher behaviour are positively related to student attitudes. In reference to the Dominance scales of the model, the DO, DC and CD scales are positively related to student achievement and the SC, SO and OS scales are negatively related to student achievement. It is important to note that this study supported previous research regarding student achievement. It identified the fact that students achieved better in classes perceived by students to have less friction and disorganization and more cohesiveness, satisfaction and goal-directedness. The study concludes with findings that suggest that there is relation between the curriculum the teacher adheres to and student outcomes. This raises the issue that curriculum change can only be effectively implemented if it is supported by changes in teacher behaviour and attitudes (Wubbels & Brekelmans, 1997). A unique comparative study was conducted in The Netherlands comparing student perceptions of Dutch physics teachers' interpersonal behaviour in 1984 and in 1993.

This study also included teachers' self-perception of their behaviour and their opinions about physics education. In 1993, the teachers were found to be more in favour of realistic teaching content than in 1984, and the analysis of the factor scores illustrate that in the eyes of the students, teachers were less dominant and more cooperative between 1984 and 1993. Another significant finding was that students believed that teachers in 1993 gave more freedom and responsibility, showed more understanding and were more friendly and helpful. However, in the eyes of the teacher, their interpersonal behaviour did not alter significantly between 1984 and 1993. This study supports the opinions in previous research, that students' perceptions are a better measure of teacher behaviour than are the teachers' perceptions.

Brekelmans and Wubbels (1992) sampled Dutch data involving 1,156 teacher-class combinations in a variety of subjects. The study involved 19,671 students and 542 different teachers. The QTI was implemented to students in over 100 secondary schools in The Netherlands. The students answered the QTI in reference to their teachers and the teachers answered the QTI describing their perceived, then their ideal behaviour. The significant outcome of this research shows, that students and teachers do not agree about their perception of teacher interpersonal behaviour. In particular, 'the divergence between perceptions of teachers and students is largest for teacher-class combinations with types of interpersonal teacher behaviour more often accompanied with lower student outcomes' (Brekelmans & Wubbels, 1992, p. 27).

To validate the elementary school version of the QTI, Goh and Fraser (1996) applied the questionnaire to 1,512 students in 39 fifth grade classes in 13 randomly selected schools in Singapore. The study focused on the application of the QTI for use in secondary schools and paid particular attention to gender differences in students' perceptions of teachers' interpersonal behaviour. There were two notable alterations to the long 64-item version and the short 48-item version. Initially, the vocabulary used was altered to cater for younger reading ages and secondly a three-point response format was utilized. Amongst the findings, girls consistently rated the teachers' interpersonal behaviour more favourably than did boys. The study provided conclusive evidence that each scale displayed satisfactory internal consistency reliability and validity for two levels of analysis. Further cross-validation of the elementary version was recommended for comparisons in other countries and in other elementary year levels.

A ten-year study on effective teaching was completed by Levy, Wubbels, Brekelmans, and Morganfield in 1994. The study that was conducted in the USA focused on whether language and cultural backgrounds influenced students' perceptions of teacher interpersonal behaviour. This research involved 550 students from 38 classes, 117 being Hispanic, 111 of Asian extraction and 322 from the USA. Each class was composed of a mixture of these three cultures. Students were also interviewed in order to establish their perceptions of whether teachers behaved differently toward different cultural groups. Findings from this study indicated that the Latin American students perceive teachers as more dominant than do the other cultural groups. Also, the greater the percentage of USA/English students in class, the teacher was viewed as more submissive. Overall, teachers were not seen as behaving differently toward students of different cultural groups in the same class.

The QTI has also proved to be a valuable instrument in assessing teacher interpersonal behaviour in primary schools. An extensive study was conducted in Brunei Darussalam, where 3,104 students from 136 classrooms in 23 coeducational government schools participated in the analysis of teacher interpersonal behaviour in science classes and students' enjoyment of science classes (Scott & Fisher, 2000, 2003). The influence that teacher interpersonal behaviour had on exam results was the third variable analysed in this study.

A feature of this study was the effort exerted to translate the 48-item Australian version of the QTI (Goh & Fraser, 1996) into Standard Malay. The response format was simplified to a 3-point Likert scale to aid the understanding of the answering process for these school students. The *Questionnaire on Teacher Interaction Elementary* (QTIE) was administered to all year 4, 5 and 6 year students in one region and year 6 students in another. This study also utilized the *Enjoyment of Science Lessons* (ENJ), (Fraser & Fisher, 1982).

In the pilot study, an analysis of the data identified two items that impacted negatively on two of the scales, however, after removing two items, the QTIE was noted as a valid and reliable instrument for use in the sampled Malay speaking elementary school students. Using the one-way analysis of variance (ANOVA), it showed that the scales did significantly differentiate between classes. Scale means illustrated that students in the Malay study perceived their teachers as mostly good leaders, helping/friendly, understanding and strict, seldom allowing student responsibility and freedom, seldom uncertain or dissatisfied and seldom admonishing.

Findings in relation to cognitive achievement suggested that for students to achieve at a higher standard, teachers needed to adopt less uncertain and dissatisfied actions, as well as more leadership, helping/friendly and understanding behaviours. Also, students' enjoyment of their science classes was strongly and positively associated with their *Primary Certificate Examinations* (PCE) results. It implied that students who enjoyed science lessons would be expected to achieve higher scores on their science PCE. Thus, the pilot study of 2001 enabled the Malay translation of the elementary version of the Questionnaire on Teacher Interaction to be reliable and valid. The 2001 study showed that students' enjoyment of science was influenced by teachers' classroom interpersonal behaviour. Statistically significant was the fact that the multiple correlation (R) was 0.57. The R^2 value of 0.32 indicated that 32% of the variance in students' enjoyment of their science lessons was influenced by teacher interpersonal behaviour.

An extension of this study conducted in 2003 also showed significant statistical associations ($p<0.01$). Students' enjoyment of science lessons was associated with all eight scales of the QTIE. The multiple correlation (R) was statistically significant at 0.62, and the R^2 value of 0.38 indicated that 38% of the variance in students' enjoyment of their science lessons could be attributed to their perceptions of their teachers' classroom behaviour. Another significant finding was the association between cognitive achievement and QTIE scales. The multiple regression (R) was 0.41, and the R^2 value of 0.16 indicated that 16% of the variance in students' cognitive achievement on their science PCE was determined by their teachers' classroom behaviour and enjoyment of their science lessons.

It was evident from these studies in Brunei Darussalam, that teachers' classroom behaviour was an important factor that influenced students' enjoyment of their science lessons. In particular, helping/friendly teacher behaviour had more impact than other QTIE scales on students' enjoyment of their science lessons. The ENJ scale proved to be useful for determining students' attitude to science lessons in primary schools in Brunei. When teachers interacted with their students in a more helping/friendly manner, students enjoyed their lessons more. In relation to cognitive achievement and the QTIE scales, leadership, helping/friendly and understanding behaviours were positively correlated and uncertainty was negatively correlated. Thus, if teachers were to demonstrate more leadership type behaviour and less uncertainty, then this would impact positively on students' science PCE scores.

A study that also effectively used the QTI was one administered by Brekelmans, Wubbels, and Créton (1990). The QTI was conducted with year 9 physics students from 65 classrooms to investigate students' perceptions of their teachers. The investigation was carried out as a Dutch option of the Second International Science Study. Some of these classes were utilizing traditional curriculum and twenty-one classes were implementing a new curriculum.

The study revealed a strong relationship between interpersonal teacher behaviour and affective student outcomes compared to cognitive student outcomes. The results suggested that to obtain high affective student outcomes, teachers needed to show more leadership, helping/friendly and understanding behaviour and less dissatisfied and admonishing behaviour. For students to attain better cognitive outcomes, strong leadership and strict behaviour have a positive influence. There was no relationship between the curriculum used and student outcomes.

Another Dutch study conducted by Terwel, Brekelmans, Wubbels, and van den Eeden (1994) investigated gender differences in perceptions of the learning environment in physics and mathematics education. The study utilized two separate research projects. The first focused on the perception of interpersonal teacher behaviour and the openness of the environment in physics classrooms. The second analyzed classroom environment instruments in curriculum research in secondary mathematics classrooms using *The Perceptions of the Curriculum in Action Questionnaire* (PCAQ). The first project involved the use of the QTI involving 33 year 9 physics classes totaling 596 students, 33 different teachers from 33 different schools. The Dutch 77-item version of the QTI analysed both teachers' and students' perceptions of teacher interpersonal behaviour. The second study involved 23 classes from six secondary schools, sampling 572 students.

In relation to the Physics Project, the QTI scales recorded Cronbach alpha values ranging from 0.71 to 0.90 when using the class mean as the unit of analysis. The results indicated that there was no significant relationship between gender and two dimensions of interpersonal behaviour. The Maths Project produced findings that suggested that boys perceive their learning environment as more reality centred and more task-oriented than do girls. There was also a significant relationship between curriculum and cooperation. Also, it was found that the more boys in a class, the more cooperation occurred between students. It was emphasized in this study that even although gender differences were found, further research needed to be instigated to determine what specific factors influence boys' and girls' perceptions of learning environments.

The QTI has also been used to effectively examine interpersonal behaviour of trainee teachers. Lourdusamy and Khine (2001) devised a study, in order to assist trainee teachers with self-analysis in relation to their interpersonal behaviour and their interaction of students in the classroom. The Australian version of the QTI was used in this study involving 200 of the 670 responses. The sample included 110 females and 90 males. The trainees were pursuing the Arts (38.5%), Science (32.5%) or Mathematics (29%). The Cronbach alpha reliability coefficients ranged from 0.62 to 0.86, thus similar to those recorded in previous studies involving the QTI. Generally, the trainee teachers viewed themselves as high in relation to leadership, friendliness and understanding, yet reticent to give students freedom. They saw themselves as strict and rarely expressed uncertain, dissatisfied or admonishing behaviours. Males perceived themselves to show more leadership and helpful/friendly behaviours than females. However, the females showed more uncertain and admonishing behaviour than males. There appeared to be no relationship between the major that the trainee was studying and interpersonal behaviour.

Recently, cross-national validity of the QTI proved to be a most salient piece of research investigating science teachers' interpersonal behaviour in six countries (den Brok, et al., 2003). This study investigated two research questions. Firstly, to what degree the QTI is capable in reliably and consistently measuring differences in interpersonal style between classes/teachers in six countries. Secondly, to what degree students' perceptions, measured with the QTI, represent the *Model for Teacher Interpersonal Behaviour* (MITB) in each of the six countries. To make country comparisons valid, researchers only assessed secondary school science teachers, however, Slovakia provided information from mathematics teachers. The number of students and teachers who were sampled in each country varied significantly, from 490 in Slovakia to 1,713 in Singapore. The average group size ranged from 14.1 in The Netherlands to 34.3 in Singapore. It is interesting to note, that all schools except those in the USA rated their teachers as being highly experienced. Students in each country completed the QTI in their respective language. Countries also varied in relation to which version of the QTI that was utilized. However, for comparative purposes, the same 48 items present in the Australian, Singapore and Brunei versions were selected from the Dutch, American and Slovakian samples.

For most countries the reliability of the sector scores at the class level, was above 0.80, however, the reliability was lowest for the student responsibility/freedom sector (SC) recording 0.73 in The Netherlands and in three countries, 0.76 was recorded for the strict sector (DO). On average, Australia recorded the highest score of 0.90 and the lowest being 0.84 for Brunei. The intra-class correlations varied between countries and sectors. The largest difference occurred in the Dutch sample recording an average intra-class correlation of 0.41, whereas the smallest differences of 0.24, 0.25 and 0.24 were recorded for the USA, Australia and Brunei respectively. These results indicate that the QTI was able to decipher differences between teachers in the Netherlands (0.41) and, for example, Slovakia (0.28) than in the USA, Australia and Brunei. The Multilevel Lambda (consistency) on average was above 0.80 in all countries.

General findings in relation to the validity of testing the five assumptions that lay behind the circumplex models, indicated that some sectors display huge amounts of overlap and may suggest that sectors could be omitted from the model. The study also proved that the short versions of the QTI are almost equally valid as the longer versions. Thus, due to this valuable research, the QTI was deemed to be cross-country comparable in terms of validity.

Another study that endeavoured to validate the QTI and investigate associations between students’ perceptions of teacher-student interactions and science related attitudinal measures was conducted in Brunei (Khine & Fisher, 2002). A sample of 1,188 students in ten secondary schools in Brunei completed the QTI. Not only did the study investigate the validity of the QTI for use in Brunei, it identified significant associations between students' perceptions of teacher-student interactions and the gender of students. Female students were identified as being more positive toward the leadership displayed by their teacher and the understanding and helping/friendly behaviours of their teachers. Five of the eight QTI scales were found to be associated with the enjoyment of science lessons and attitude to inquiry.

The QTI was administered to 543 male and 645 female students in the equivalent of year 11. The average class size was 27 students and the sample represented 50% of the total population of Form 5 students in government secondary schools in Brunei. Two scales from the *Test of Science-Related Attitudes* (TOSRA) (Fraser, 1981) were selected to measure students' attitudes to science. The Cronbach alpha reliability for Attitude to Scientific Inquiry and Enjoyment of Science Lessons' scales were 0.65 and 0.93 respectively. The highest alpha reliability was 0.83 for individual scores and 0.94 for class means for the Helping/Friendly scale. The lowest reliability was 0.49 for the individual and class means for the Strict scale. Interestingly, it was suggested that the low value for the means in the Strict scale were due to the fact that students of Brunei were reticent to comment about this behaviour of their teacher.

The study used a one-way ANOVA analysis of variance to differentiate between perceptions of students in different classes. The eta^2 statistic, that indicates the strength of association between class membership and the dependent variable, ranged from 11% to 32% and proved to be statistically significant for all scales. Thus, it showed that the instrument is able to differentiate clearly between the perceptions of students in different classrooms. The study identified positive and close correlations between adjacent scales, namely Helping/Friendly with Leadership (0.72) and Understanding (0.75). The Dissatisfied scale recorded the highest negative correlation (-0.41) with the Helping/Friendly scale.

Simple and multivariate correlation analysis was implemented to explore associations between teacher-student interactions and students' attitudes. There were significant positive correlations ($p<0.01$) between Leadership (0.33), Helping/Friendly (0.36) and Understanding (0.37) scales and negative correlations between Uncertain (-0.24), Dissatisfied (-0.27) and Admonishing (-0.30) and students' enjoyment of science. The multiple correlation (R) was 0.42 (p<0.001) between the set of QTI scales and students' enjoyment of their science lessons. Thus, the proportion of variance in enjoyment of science that can be attributed to students' perception of teacher-student interactions was 18%. The scales that contributed to this association were assessed using the standardized regression coefficient (β) for each scale. The Understanding scale was positively associated (0.15) and the Admonishing scale was negatively associated (-0.13) with the Enjoyment of Science.

The analysis of students' attitudes towards scientific inquiry and their perceptions of teacher-student interactions indicated that only the Understanding and the Helping/Friendly scales were found to be significantly correlated. The multiple correlation (R) was significant at 0.11 (p<0.01) and the R^2 value was only 1%, which suggests a very insignificant effect.

The association between students' perception of teacher-student interactions and the gender of students, indicated that females perceived the Leadership, Understanding and Helping/Friendly behaviours of their teachers than males. However, male students perceived that their teachers displayed more admonishing and dissatisfied behaviours.

2.5.2 Australian Studies

The QTI has been extensively used in Australian settings including biology and mathematics classes. Initially in Australia, the QTI was utilized in a study that investigated associations between school learning environment and teacher interpersonal behaviour (Fisher, Fraser, & Wubbels, 1993; Fisher, Fraser, Wubbels, & Brekelmans, 1993). The *School Level Environment Questionnaire* (SLEQ) was also used and validated in that particular study. The investigation was conducted in seven schools in Western Australia and Tasmania. Forty-six teachers completed the SLEQ and two copies of the QTI. One QTI assessed teachers' perceptions of their interpersonal behaviour and the second revealed what these teachers believed to be ideal teacher interpersonal behaviour. The teacher then chose one of their classes to complete the QTI. The total number of students who completed the QTI was 792.

The students' results were analysed to determine their perceptions of teacher interpersonal behaviour in their class. This study distinguished between school-level and classroom environment, and identified the development of the SLEQ. The results proved to be useful for teacher professional development in various areas of student management. Both the SLEQ and the QTI were deemed to be valid and reliable instruments and provided avenues whereby teachers gained valuable insights about teacher-student relationships. The major finding in this study was that there was a weak relationship between the QTI and the SLEQ scores and that a teacher's behaviour in class has little impact on how one perceives the school environment.

Another significant study using the QTI was administered to 792 students in year 11 science and mathematics classes in Western Australia and Tasmania. Wubbels (1993) also involved 46 teachers in this study that saw the use of the more economical 48-item version of the QTI. This study involved students answering two QTI questionnaires. One focused on gathering information from students about their perceptions of their mathematics and science teachers' interpersonal behaviour. The second questionnaire completed by the students, identified their perceptions of their best teacher. The teachers also completed two copies of the QTI and in so doing, forwarded their perceptions of their ideal teacher behaviour and perceptions of their own behaviour. Results of this Australian study were similar to those conducted overseas. Both the teachers' and students' profiles identified the teachers to be strong on leadership and revealed friendly and helpful behaviour, although teachers on average showed higher scores (Wubbels, 1993, p. 5). Uncertain, dissatisfied and admonishing behaviours were not evident from the analysis.

It was apparent from this study, that teachers were more satisfied with their behaviour than were the students. Students identified best teachers as those who are strong leaders, more friendly and understanding and less uncertain, dissatisfied and admonishing, and in particular those who give students more responsibility. There were two distinct types of teachers who were identified by the teachers in this study. The first type was the teacher who shows cooperative behaviour and a sense of leadership and strictness. The second type outlines behaviour that promotes responsibility and freedom. Students also identified two types of best teachers.

Some students preferred a strict teacher, while others prefer to be given more responsibility and freedom.

Fisher, Henderson, and Fraser (1995) completed a study in Tasmania using the QTI for the first time in senior high school biology classes. The study describes students' perceptions of the interpersonal relationships with their teachers in the classroom environment. In particular, the study focused on 'associations between students' perceptions of interpersonal relationships with their teachers and student attitudinal, cognitive and practical performance outcomes' (Fisher, Henderson, & Fraser, 1995, p. 125).

The study successfully revealed cross-validation for the QTI when used in biology classes. The Cronbach alpha reliability figures for different QTI scales ranged from 0.63 to 0.83 for individual student analysis, and from 0.74 to 0.95 when the class mean was the unit of analysis. Results confirmed the internal consistency of the QTI and were similar to results reported in the USA (Wubbels & Levy, 1991). The QTI was identified as being able to differentiate between the perceptions of students in different classrooms. Fisher, Henderson, and Fraser (1995) found that 'each QTI scale differentiated significantly ($p<0.001$) between classes and the eta^2 statistic, representing the proportion of variance explained by class membership, ranged from 0.20 to 0.48 for different classes' (p. 129).

The study identified that biology teachers who are good leaders in their classrooms in relation to their teaching routines, are more likely to have high achieving students in their classrooms. The Strict scale correlated negatively with student performances on practical tests and students who were given more freedom and responsibility in practical work, showed a positive correlation. Thus, the impact that teacher interpersonal behaviour has on student outcomes in relation to attitudes and achievement was seen to be significant.

A similar study conducted by Henderson, Fisher, and Fraser (2000) utilized the QTI to investigate students' perceptions of their biology teachers' interpersonal behaviour and also incorporated an analysis of students' laboratory learning environments and their attitudinal, achievement and performance outcomes. The Science Laboratory Environment Inventory (SLEI) and the QTI were administered to the sample of 489 students from 28 biology classes in Tasmania. The QTI was used to monitor students' perceptions of interpersonal behaviour and the SLEI to assess students' perception of the laboratory environment.

Students completed two forms of the QTI that provided their assessment of their actual and preferred classroom environment. They also completed two forms of the SLEI that rated their current laboratory environment and their preferred laboratory environment. This study supported the reliability and validity of the QTI and the SLEI for use in senior biology classrooms. It was beneficial in that it identified aspects of the learning environment that were likely to promote student attitude and achievement. In particular, the study identified that favourable student attitudes were found to be associated with a student's perception of a teacher's strong leadership, a greater degree of integration of practical and theory work, and more rule clarity.

A unique study by Stolarchuk and Fisher (1998) investigated the impact that laptop computers have on students' attitudes, achievement outcomes and their perceptions of teacher-student interpersonal behaviour in science classrooms. As well as the QTI being utilized to assess students' perceptions of teacher interpersonal behaviour, students' attitudes were analyzed using a scale from the Test of Science-Related Attitudes (TOSRA), (Fraser, 1981). Scales from the *Test of Enquiry Skills* (TOES) instrument measured students' achievement. These three instruments were administered to 433 laptop students in 23 different science classrooms and 430 non-laptop students in 21 science classrooms. The students were in years 8 and 9 science classes in 14 Independent schools in four Australian states.

This study enabled the validity and reliability of the QTI to be recognized for use in science laptop research. Positive associations between students' perceptions of teacher interpersonal behaviour and students' attitudinal and cognitive achievement outcomes were also noted. The 48-item economical version of the QTI developed in Australia (Wubbels, 1993) was utilized in this study. The validation statistics of this version of the QTI recorded the Cronbach reliability coefficients, based on an

Australian sample using the individual student unit of analysis, ranging from 0.68 to 0.85 and at a class level 0.80 to 0.95, indicating high internal scale consistency (Wubbels & Levy, 1993, p. 166).

This study certainly confirmed the QTI as a valid and reliable instrument for analyzing science laptop classroom environment. The scale internal consistencies were confirmed by Cronbach alpha coefficients ranging from 0.55 to 0.88 using the individual student, and 0.55 to 0.97 using the class mean as the unit of analysis. The study identified the necessity to use discretion when interpreting the findings associated with the Student Responsibility/Freedom scale due to low alpha coefficients recorded. Stolarchuk and Fisher (1998) note that 'the ANOVA eta^2 statistic calculated for each scale, representing the proportion of variance due to class membership, ranged from 0.14 to 0.44 ($p<0.001$); therefore, indicating satisfactory scale differentiation' (p. 4). Thus, these values confirm the validity and reliability of the QTI for use in analyzing laptop use in science classroom research.

The multiple correlation statistic of 0.63 ($p<0.001$) indicates that the association between laptop students' perceptions of teacher-student interpersonal behaviour in science classes and students' attitude to science is quite strong. The multiple correlation statistic of 0.33 ($p<0.001$) illustrates a significant association between laptop students' perceptions of teacher-student interpersonal behaviour in science classes and students' cognitive achievement.

Teacher personality using the *Myers-Briggs Type Indicator* (MBTI) and the QTI were utilized in a study conducted by Fisher, Kent, and Fraser (1998) to examine associations between student and teacher perceptions of teacher-student interpersonal behaviour and teacher personality. The study was administered in Tasmania to 108 teachers and 1,883 year 11 and 12 students from government schools. The results from the QTI showed acceptable internal consistency reliability. Values for alpha coefficients ranged from 0.66 to 0.83 using the individual student as the unit of analysis and from 0.83 to 0.93 using the class as a unit of analysis.

This study identified a moderate association between teacher personality and interpersonal teacher behaviour. There was also a positive association between teacher personality and self-perception compared to teacher personality and student perception of teacher interpersonal behaviour. The study also identified that teacher personality is consistently associated with teacher self-image. Students' perceptions of their teachers' interpersonal behaviour, were found to be related to the personality of the teacher in regards to the level of freedom and responsibility they grant their students.

A study conducted by Rickards and Fisher in 1999 was designed to determine associations between science students' perceptions of their interactions with their teachers, their cultural background of students and their attitudinal and cognitive achievement. The study involved 3,215 students from 158 science classrooms in 43 schools in Tasmania and Western Australia. Again the QTI proved to be a valuable instrument, with the alpha reliability figures for the QTI scales ranging from 0.62 to 0.88 when the individual student was used as the unit of analysis. When the class mean was used, the values ranged from 0.72 to 0.92, again supporting the internal consistency of the QTI. A one-way ANOVA analysis that enabled comparisons between perceptions of students in different classrooms was also conducted. Results indicated that each QTI scale differed significantly ($p<0.001$) between classes and the eta^2 statistic ranged from 0.17 to 0.31 for different scales. Gender analysis revealed that females perceived their teachers in a more positive light than did males.

In relation to attitude to science, there were positive correlations for the Leadership, Helping/Friendly and Understanding scales and negative associations for the Uncertain, Dissatisfied, Admonishing and Strict scales. Significant associations were also identified for cognitive achievement. There was found to be a higher level of cognitive achievement where teachers demonstrated more leadership, helping/friendly and understanding behaviours and less uncertain, strict, dissatisfied and admonishing behaviours. In particular, this study provided avenues for further research into differences in males' and females' perceptions of teachers and an analysis of differences in cultural background and the varying perceptions of the same classroom environment.

Another study that involved biology classes and utilized the QTI was conducted by Fisher, Rickards, Goh, and Wong in 1997. This study confirmed cross-cultural validity of the QTI and identified significant differences in students' perceptions of teachers in two countries. The QTI was administered to 720 students in 20 year 8 and 9 science classes in Singapore and 705 students in 29 year 8 and 9 science classes in Australia, as well as to teachers in both countries. Student attitudes were assessed with a seven-item *Attitude to This Class* scale based on the TOSRA (Fraser, 1981).

The results from the Singapore study indicated that the Cronbach alpha reliability values ranged from 0.50 to 0.88 using the student as the unit of analysis and from 0.60 to 0.98 when the class mean was used as the unit of analysis. In comparison, the Australian alpha reliability values ranged from 0.60 to 0.88 and 0.64 to 0.96 respectively. The one-way ANOVA was used to assess the effectiveness of the QTI in differentiating between students' perceptions in different classrooms. The QTI scale differentiated significantly ($p<0.001$) between classes and the eta^2 values ranged from 0.13 to 0.47 in Singapore and from 0.15 to 0.40 in Australia.

The study confirmed the reliability and validity of the QTI for use in science classes in Australia and Singapore. Significantly, students' attitude scores were higher in classrooms in which students perceived greater leadership and helping/friendly behaviours in their teachers. The differences found between students' perceptions of science teachers in Singapore and Australia were quite small. However, Australian teachers were perceived as giving more responsibility and freedom to their students, while the teachers in Singapore were perceived as more strict.

A distinctive study by Fisher and Cresswell (1997) investigated principal interpersonal behaviour by using the *Principal Interaction Questionnaire* (PIQ) that was devised from the QTI. The similarities in its function enabled valid conclusions to be drawn regarding interpersonal behaviour. The questionnaire was distributed to 56 schools in Australia, where it was completed by the principal and 20 teachers in each school. Forty co-educational and 16 single-sexed schools were involved in the study. The sample of principals had an average of 9.4 years experience as principal.

The principals completed two copies of the PIQ, an actual and a preferred perception of principal interpersonal behaviour. The teachers involved also answered two questionnaires assessing their perception of principal interpersonal behaviour and their preferred principal behaviour.

The analysis proved that the PIQ was a valid and a reliable instrument to measure perceptions of principals' interpersonal behaviour. Principals appeared to score highly on the cooperation side of interpersonal behaviour and lowly on opposing behaviour. In fact, they seemed to be not overly dominant or submissive. A comparison of the teachers' actual and preferred perceptions showed that an ideal principal should display even more cooperative behaviour and less opposing interpersonal behaviour.

Rickards, Fisher, and Fraser (1996) investigated associations between science and mathematics students' perceptions of their classroom learning environments, cultural backgrounds of students and their attitudinal and achievement outcomes. The study involved approximately 4,000 students from 185 secondary school science and mathematics classes in 42 schools who completed the QTI, an attitude to class scale and questions relating to cultural background. The attitude to class was assessed using a seven-item scale based on the TOSRA (Fraser, 1981). This Australian study involved students from schools in Western Australia and Tasmania.

Again the QTI was found to be a reliable and valid instrument for assessing students in secondary school science and mathematics classrooms. The alpha reliability figures ranged from 0.63 to 0.88 when the individual student was used as the unit of analysis. When the class mean was used, the values ranged from 0.78 to 0.96. A one-way ANOVA found that each QTI scale differentiated significantly ($p<0.001$) between classes and that the eta^2 statistic representing the proportion of variance explained by class membership ranged from 0.22 to 0.35 for different scales. Thus, the dimensions of the QTI were found to be significantly associated with student attitude scores.

Overall, the study showed that there was a positive correlation between student attitude and teachers' leadership, helping/friendly and understanding behaviours. A negative correlation was identified between student attitude and teachers' admonishing, dissatisfied, uncertain and strict behaviour. In particular, this study determined that female students perceive their teachers more favourably than do male students. Also, students from Asian backgrounds tended to perceive their teachers in a more positive light.

A study carried out by Fisher and Rickards (1996) proved to validate for the first time, the use of the QTI with a large group of mathematics classes. In particular, they assessed the effectiveness that teacher-student interpersonal behaviour had on students' attitude towards their mathematics classes. The results of the QTI proved to be quite useful in providing teachers with an opportunity to reflect on their own teaching. This study involved 405 students from year 8, 9 and 10 in nine schools and included 21 teachers in the analysis. The Attitude to This Class scale that was based on the TOSRA (Fraser, 1981) was also used.

The alpha reliabilities for different QTI scales ranged from 0.62 to 0.88 when the individual student was used as the unit of analysis, and from 0.60 to 0.96 when the class mean was used as the unit of analysis. A one-way ANOVA test found that the QTI scale differentiated significantly ($p<0.001$) between classes and that the eta^2 statistic ranged from 0.14 to 0.43 for different classes. The study found that the dimensions of the QTI were certainly associated with student attitude scores. As with previously mentioned studies, student attitude scores were higher in classrooms in which students perceived greater leadership and helpful/friendly behaviours in their teachers. The strictness and dissatisfaction of teachers proved to have a detrimental impact on students' attitude scores.

The numerous studies that have been presented and reviewed here have solidified the validity and reliability of the QTI as an instrument for assessing students' and teachers' perceptions of teacher interpersonal behaviour. More recent studies using the QTI (Fisher & Rickards, 2000; Scott & Fisher, 2000) continue to solidify the ability of the QTI to assess teacher interpersonal behaviour. This literature review, has described the QTI as an instrument that can be implemented in a variety of settings, for example, geographically diverse locations (Waldrip & Fisher, 2000a), recording alpha coefficients from 0.67 to 0.88 suggesting acceptable reliability. It is evident that the effect of teacher interpersonal behaviour in relation to student attitude, achievement, gender and cultural background is of prime importance in identifying where teacher professional development opportunities should be directed, and when better classroom practices need to be adopted. The versatility of this instrument in the variety of classroom settings portrayed here provides avenues for further areas of investigation to be implemented.

Treagust (1991) investigated exemplary teachers by describing two exemplary biology teachers who possessed classroom management practices that allowed for effective student learning. Most recently a study (Waldrip & Fisher, 2003) used the QTI to identify and describe exemplary science teachers. Not only did this study validate the QTI by recording Cronbach alpha coefficients ranging from 0.69 to 0.87, the study was particularly concerned with questioning why students were disinterested in science and not choosing to pursue science subjects in post-compulsory years of schooling. It also identified and examined the behaviour of exemplary science teachers as identified from students' perceptions on the QTI scales. Exemplary teachers were identified as those whose students' perceptions were more than one standard deviation above the mean on the scales of Leadership, Helping/Friendly and Understanding scales and about one standard deviation below the mean on the Uncertain, Dissatisfied and Admonishing scales. According to Waldrip and Fisher (2003), a teacher may display various levels of competencies, but lack the skills to implement these into effective teaching techniques. Productive studies such as these provide further evidence on the validation of the QTI.

2.6 SUMMARY

This comprehensive overview of classroom environment instruments and the assessment of teacher interpersonal behaviour has illustrated a definite relationship between students' engagement in classroom activities and their perception of teacher interpersonal behaviour. Although an extensive amount of literature has been cited here in reference to teacher interpersonal behaviour and the identification of classroom environment instruments, research has not been conducted that involves the QTI in conjunction with both students' motivation and attitudes.

The next chapter presents a literature overview of student motivation in science classrooms and student attitude towards science. It addresses the significance of teacher interpersonal behaviour and its influence on the development of the level of student motivation and student attitudes towards science. It also highlights significant studies that have utilized instruments to analyse students' motivation and attitudes in science classrooms. It is also the intention of this research to identify factors that may collectively lead to making the learning environment more conducive to student learning and to the enjoyment of science.

CHAPTER 3

LITERATURE REVIEW: STUDENT MOTIVATION AND ATTITUDE IN THE SCIENCE CLASSROOM

3.1 INTRODUCTION

This chapter provides an overview of the theoretical frameworks associated with students' motivation and attitude towards science. Each dimension is discussed separately to establish an understanding of theories behind the varying levels of students' learning needs in the science classroom. Significant studies that have addressed these topics are then presented and allow valid comparisons to the quantitative and qualitative data obtained in this particular study. This chapter highlights factors in classroom settings that perhaps unintentionally, affect students' levels of motivation and their attitude towards science. It was anticipated throughout this study that this research would confirm that teacher interpersonal behaviour has a direct influence on students' motivation to want to learn science, their self-efficacy and can determine students' attitudes towards science.

3.2 AN OVERVIEW OF MOTIVATION IN EDUCATION

Lumsden (1994) identified student motivation as the desire to be involved in the learning process. Weiner (1990) acknowledged that initially 'motivational psychologists were concerned with what moved a resting organism to a state of activity' (p. 617). The study of motivation was thought to be separable from learning in that 'motivation examines the use, but not the development of knowledge' (Weiner, 1990, p. 618). Motivation is dependent on internal or external factors that explain one's level of involvement in an activity. Intrinsically motivated students are directed by the enjoyment of acquiring knowledge and the sense of accomplishment it brings. Whereas, extrinsically motivated students rely upon receiving rewards or avoiding punishment to motivate their level of performance. They tend to exert a minimal amount of effort to obtain the maximum reward (Lepper, 1988).

Motivation can be viewed as being responsible for energizing and directing students' goals. 'A person seems to maintain his energy and directionality without apparent reinforcement from outside. Such motivation is called intrinsic. Unrewarded behaviour is often considered more desirable than extrinsic motivation, which depends on observable rewards' (Gage & Berliner, 1979, p. 315).

Martin (2003) viewed motivation as 'students' energy and drive to learn, work effectively, and achieve to their potential at school' (p. 32). He also purported that motivation plays a significant part in determining students' interest in and enjoyment of school, the learning process and ultimately achievement. Martin (2003) described the Student Motivation Wheel that divides motivation into factors that identify enhanced, constrained and reduced motivation; called *boosters* (e.g. self-belief, persistence, learning focus and value of schooling), *mufflers* (e.g. anxiety and fear of failure) and *guzzlers* (e.g. low control and self-sabotage) respectively. His theory explained how effective boosters can be in improving one's academic level and how the presence of mufflers and guzzlers can stifle motivation, self-belief, performance and enjoyment of learning. He also emphasized the influence that parents have on determining their child's motivation and was adamant that unmotivated students can become motivated and motivated students can sustain their levels of motivation. One of the most important findings in his research identified the fact that fear of failure is usually experienced by students who experience self-doubt and anxiety. Motivated students view poor performance to be a learning experience that encourages future success.

3.2.1 Students' Needs

It is understood that student motivation requires sensitivity to others' values and needs, thus an emphasis on cooperative learning is essential in the classroom. Students need a sense of belonging to be able to develop their autonomy and individuality. Adolescents possess a wide range of abilities and learning needs, and these should be identified early so that teaching may benefit each individual in the classroom. Hofstein and Kempa (1985) believed that teachers have been encouraged to adopt particular learning styles without questioning whether they are suitable for every learner or every teacher. Peters (1965) stated 'we teach children, not subjects, hence, the need for teachers to understand what psychologists have discovered about individual differences and child development' (p. 90). It is imperative that teachers identify the ranges of cognitive development among students and cater for them accordingly.

The degree to which a student needs to be aroused to achieve optimal learning varies immensely from classroom to classroom. Arousal is a delicate variable that endeavours to enhance motivation, however, it can also be responsible for students becoming unnecessarily anxious and adopting a fear of failure that can then lead to poor performance (Gage & Berliner, 1979). Orbach (1979) claimed that there is no doubt that the needs felt by the student in the context of school life are not identical. Hofstein and Kempa (1985) stated that teachers 'face the task of having to cater for a variety of students of different needs and different motivations towards the learning of science' (p. 228). Every student learns differently and the teaching strategies adopted by the teacher to suit one student may not be effective on other students. Thus, teachers must be aware of their students' learning needs and endeavour to stimulate their interest in order to encourage them to want to learn. Various theorists have endeavoured to explain the stages of development of individuals and their behaviour.

3.2.2 Maslow's Hierarchy of Needs

Maslow (1970) identified a hierarchy of motivational needs that influence behaviour. His theory explains a continuum that involves physiological, physical and psychological needs. Maslow's hierarchy assumes that certain needs have strength over other needs. However, a need does not have to be fully satisfied at one level to see the emergence of others at another level. Maslow's hierarchy begins with physiological needs that indicate a person's acquisition of basic needs. Once these needs are met, new needs at the next level, safety and security, followed by belongingness, self-esteem and self-actualization may emerge and influence motivation. However, Trowbridge, Bybee, and Sund (1981) stated that 'the structure and function of the hierarchy should be viewed holistically and all needs influence motivation to some degree' (p. 66). They also believed that Maslow's theory has significant implications for science teachers: 'to be aware of the influence of unfulfilled lower needs on behaviour and to encourage growth and personal development toward a goal of self-actualization' (p. 66).

One of Maslow's major findings inferred that there is a dual process of equalization and actualization that contributes to the continued development of the whole person. Equalization is the process by which the lesser needs are fulfilled. Actualization represents the needs that influence the individual towards continuing change and growth. These four needs are considered to be higher needs: knowledge, creative, ethical and aesthetic (Trowbridge, Bybee, & Sund, 1981). Thus, Maslow's theory highlights the fact that learning, behaviour and development are influenced by motivational needs, providing an excellent model for understanding human motivation.

3.2.3 Piaget's Theory of Cognitive Development

Piaget's work on cognitive development identified a pre-moral period and two stages of moral development: heteronomous morality and autonomous morality. Heteronomous morality is experienced by children between the ages of six and ten. Piaget believed that children at this age are purely influenced by older authority figures, such as their parents who influence their moral stance on issues. Autonomous morality is developed around the age of 11 and is determined by tangible agreements between individuals. Both stages act on four aspects of morality: conception of rules, basis for judging acts, view of punishment and the nature of justice. Piaget's theory depends on 'cognitive maturation and social experience' (Sigelman & Shaffer, 1995, p. 332).

In the context of the school environment, cognitive development theorists endeavour to seek explanations for 'how we decide what to do, not what we decide or what we actually do' (Sigelman & Shaffer, 1995, p. 331). They are challenged to interpret the different reasons for students' decisions that determine their performance. Each student is unique and has developed decision-making processes that lead to developing a judgment of a situation. The moral reasoning of another student may be totally unrelated, however, they may make the same informed decision to act in a similar manner. Learning experiences in the classroom that initiate motivation may in fact differ from those that sustain it. It is debatable whether motivation is determined by an internal state of arousal or from environmental influences. Thus, it is imperative that teachers design their lessons to enable students' intrinsic motivation levels to be realised and sustained. Students' internal standards will then operate effectively when outside the control of the teacher. The theory of cognitive dissonance (Festinger, 1957) is considered to be similar to disequilibrium in Piaget's theory of cognitive development. Festinger (1957) believed if enough disequilibrium is created between two actions, or between belief and action, then an individual will adopt a change in thought processes, which will ultimately change behaviour.

3.2.4 Kohlberg's Theory of Moral Development

Kohlberg developed a theory on cognitive development based on Piaget's work. However, he formulated three levels of moral reasoning; preconventional (rules are external and children adhere to them to avoid punishment), conventional (internalizing of moral values in order to seek approval) and postconventional (definition of rules in terms of social justice) morality, to analyse moral dilemmas and within each level were two stages that assisted the reasoning (Sigelman & Shaffer, 1995). Kohlberg stipulated that once an individual reaches a certain level of moral development, he/she cannot regress to a previous level (Sigelman & Shaffer, 1995). To maximize the effectiveness of teaching, students' needs must be catered for so that students can reach their potential. All three theories possess the underlying theme of considering the motivating force behind the actions of the individual. Whether it is the acknowledgement of needs, the level of cognitive thinking or the state of moral reasoning one experiences, individuals seek explanation for behaviour from social learning theory. However, Huitt (2001) questioned whether motivation is a primary or secondary influence on behaviour. In particular, some researchers have wondered, if students' patterns could be understood more thoroughly by exploring students' cognitive ability or personality. In fact, Sigelman and Shaffer (1995) identified the fact that exposure to forms of moral reasoning more mature than their own will create cognitive disequilibrium, which motivates children to devise more mature modes of thinking.

3.3 THEORIES OF MOTIVATION

Motivation is an essential factor in attaining goals. Motivated students 'learn more effectively, and unmotivated students are more likely to cause classroom disturbances' (Gage & Berliner, 1979, p. 277). Dweck and Leggett (1988) made a clear distinction between performance and learning goals. Performance goals focus on one's ability and sense of self-worth (Ames, 1992; Covington, 1984). Ames (1992) stated that 'a performance goal fosters a failure-avoiding pattern of motivation' (p. 262). Those students who strive to achieve the highest mark are purely directed by performance goals, whereas, students who are genuinely interested in acquiring a solid understanding of knowledge are identified as pursuing learning goals.

Adar (1969) identified four major motivational patterns in relation to students' preferences for and responsiveness to different kinds of motivating actions. One group was categorized by their need to achieve, another, their intrinsic curiosity to obtain knowledge, another by their feeling of duty and finally their involvement in social interactions. Weiner (1990) made distinctions between physiological and psychological motivations. He described the latter as including three types of motivations: curiosity (the tendency for one to be aroused by the external environment; achievement (the individual to complete a task that is meaningful to them) and affiliation (a search for satisfaction through interacting with others). Early motivational research in education focused on the examination of 'intrinsic emotional and motivational properties of substances such as saccharin' (Weiner, 1990, p. 616). Kremer and Walberg (1981) found there to be a positive relationship between motivational variables and science learning. Anderman and Midgley (1998) stated that the levels of motivation demonstrated by students can be identified via three theories: attribution theory, goal theory and self-determination theory. Each of these is described in the following sections.

3.3.1 Attribution Theory

It is evident that students' perceptions of their learning experiences have a direct influence on their level of motivation (Kremer & Walberg, 1981; Napier & Riley, 1985; Trumper, 1995; Uguroglu & Walberg, 1979; Weiner, 1974). It is difficult for students to sustain motivation if they continually experience failure for no understandable reason. However, a plausible explanation for failure can assist students' level of persistence towards success. Attribution theory suggests that behaviour is motivated by the level of a person's emotional security in relation to perceptions of one's ability. Weiner (1974) proposed an attribution theory of motivation in which the explanations forwarded for the outcomes achieved, influence future expectations of success and future motivation to succeed. He endeavoured to explain how students analyse their outcomes, emphasizing 'four causes of success and failure: ability, effort, task difficulty and luck' (Sigelman & Shaffer, 1995, p. 352).

Student perception is constructed from a combination of past experiences that can then predetermine the quality of future achievements (Covington, 1984). If students attribute their success to hard work, then they feel secure and accomplished when they achieve. However, if a student is of the belief that their success has been gained purely through teacher pity or favourtism for example, then their future success is not guaranteed. Covington (1984) suggested that 'if students do not try hard and fail, they are more likely to remain optimistic about succeeding later' and 'individuals who ascribe their successes to sufficient ability will undertake similar tasks in the future because they anticipate doing well' (p. 7). He also explained that students who lack ability and believe that their successes are only due to external factors are those students who are less likely to exert themselves on set tasks. Huitt (2001) stressed the need for teachers to assist students in developing a self-attribution exploration of effort.

3.3.2 Goal Theory

Rennie (1990) stipulated that 'a teacher's management skills are important determinants of student engagement' (p. 165). Little (1994) stated that the format of the task and the manner in which it is explained and implemented could also certainly contribute to the level of student engagement and interest. If students perceive a task to lack organization or direction and that they will not be suitably challenged by it, then one would assume that the inclination for students to become spontaneously involved is reduced. Some theorists believed that variations in the types of assessment might stimulate different degrees of interest in learning tasks (Little & Singh, 1992). Motivation determines and is determined by the process and outcomes of learning. It is mediated by students' perceptions of the purpose of learning (Dweck & Leggett, 1988). Ames (1992) viewed goal theory as an explanation of why students seek to obtain knowledge, whether it is for self-approval regarding ability or purely as competition with others.

Goal theory endeavours to identify the reasons or purposes students perceive for achieving. The two main constructs are task goals and ability goals. A task goal is directed by the belief that the purpose of achieving is for personal improvement and understanding, and those students will focus on the acquisition of skills and knowledge. In comparison, an ability goal is directed by a student's desire to appear competent in front of other students. Thus, another factor that can determine student engagement and motivation is the assessment process.

Ames (1992) noted that 'the ways in which students are evaluated is one of the most salient classroom factors that can affect student motivation' (p. 264). Students' perceived relevance of assessment tasks, criteria and their frequency might have detrimental effects on student motivation and, therefore, affect their tendency to engage in the learning process. Research has suggested that 'students perceive classrooms as defining the purpose of learning in differing ways, and that these perceptions influence the goals that students themselves adopt, thereby influencing their motivation and learning' (Maehr & Midgley, 1991, p. 402). Thus, 'students can perceive classrooms as emphasizing task or ability goals and this perception is associated with the quality of motivation they exhibit' (Maehr & Midgley, 1991, p. 403). Practical work in science certainly contributes to motivating students. It is an attempt to solidify students' understanding of different concepts by socially interacting and sharing knowledge. However, Adar (1969) suggested that only socially motivated students would thrive from such experiences whilst others' learning may be hindered.

Vroom (1964) explained motivation as being dependent on three factors; expectancy, instrumentality and valence. Expectancy is perceived as the probability of success, instrumentality as the connection of success and reward, and valence as the value of obtaining a goal. This theory identified the three factors as being dependent on each other as a final determinant of the level of motivation and the resulting behaviour.

3.3.3 Self-Determination Theory

Deci and Ryan (1985) identified that students have three categories of needs: needing a sense of competence, of relatedness to others, and of autonomy. It is understandable that students need to feel a connectedness to others in their learning environment and that within the context of this environment, they experience a certain level of achievement. Autonomy suggests that students also benefit from contributing to the decisions that are often formulated in the classroom setting. These decision-making opportunities do not interfere with the overall behaviour of students; they in fact encourage students to make positive contributions to classroom activities. Ryan and Grolnick (1986) viewed there to be a positive relationship between teachers involving students in decision-making and students' intrinsic motivation.

Numerous motivational theorists have forwarded understandings of types of motives that exist within students. Pintrich (1989) divided motivation into three components: expectancy, value and affect. Expectancy described students' beliefs about their potential ability, value is determined by students' acknowledgement of the worthiness of a task and affect refers to the emotional response to a set task. Hodson (1998) addressed motivation theory and concluded that 'good learning is fostered by a shift to high-levels of learner control and personal interest, an appropriate level of intellectual challenge and minimal teacher control, but accompanied by lots of teacher guidance, support, encouragement and feedback' (p. 73).

Dweck and Leggett (1988) made a clear distinction between performance and learning goals. Performance goals focus on one's ability and sense of self-worth (Ames, 1992; Covington, 1984). Ames (1992) stated that 'a performance goal fosters a failure-avoiding pattern of motivation' (p. 262). Those students who strive to achieve the highest mark are purely directed by performance goals, whereas, students who are genuinely interested in acquiring a solid understanding of knowledge are identified as pursuing learning goals. The work of Hofstein and Kempa (1985) addressed the issue of how science education can be directed towards motivating the learner. They concluded that the nature, structuring and presentation of subject matter and the climate of the learning environment influences how students' motivation to learn can be enhanced.

Kyriacou and Rogers (1999) focussed on the understanding that teachers have in relation to sustaining high levels of student motivation. They suggested that such teachers have acquired a solid understanding of factors that have a direct influence on students' varying levels of motivation; including individual personalities, ability and home environment. Although motivation in the classroom is often deemed to be due to external factors, teachers should realize that they have the ability to alter students' levels of motivation. Kyriacou and Rogers (1999) stressed the need to emphasize the notion of motivational style in understanding student motivation. They believed that students' motivational styles may vary from subject to subject. Thus, this could suggest that teacher interpersonal behaviour has a significant influence on inhibiting or promoting student motivation. With this concept in mind, the next section of this research addresses the importance of teacher interpersonal behaviour and the impact it has on maintaining student motivation.

3.4 STUDENT MOTIVATION AND TEACHER INTERPERSONAL BEHAVIOUR

One of the aims of this study was to analyse students' perceived levels of teacher interpersonal behaviour and examine to what extent teacher interpersonal behaviour influences student motivation. It is apparent from the previous reviews, and therefore, emphasized here, that some form of motivation is required to initiate and sustain valuable learning. Teachers should be aware that they have the capacity to significantly raise the levels of student motivation. However, Adar (1969) acknowledged that the application of different teaching techniques would affect a student's motivation only if the method interacts with the student's motivational pattern.

The school environment is of paramount importance in developing the individual and their learning style. It is also reasonable to assume that students' impressions of learning environments affect students' levels of motivation. Fraser (1994) stated 'measures of environments are typically more like measures of motivation than measures of ability or achievement' (p. 93). Each student requires variable levels of motivation to enable them to reach their educational potential and sustain their performance.

McCombs (2000) revealed that 'when students are asked what is right about schools, they most frequently mention high quality human relationships in which people care, listen, are honest and open, understand and respect others' (p. 9). Such findings prompted an investigation of the usefulness of the QTI in linking interpersonal behaviour and the influence it has on student motivation. Wubbels and Levy (1993) attributed teacher interpersonal behaviour in the classroom as highly influential on students' motivation and achievement. Walberg's theory on educational productivity includes motivation as one of the nine factors that contributes to the variance in students' cognitive and affective outcomes (Walberg, 1984).

Motivated students possess a desire to learn and invariably to achieve. The level of motivation adopted by students may in fact be determined by the manner in which scientific concepts are delivered to them. Walberg (1991) stated that 'large amounts of instruction and high degrees of ability, for example, could count for little if students are unmotivated or if the instruction is unsuitable' (p. 94). Motivation is referred to 'as indicated by personality tests or the student's willingness to persevere intensively on learning tasks' (Walberg, 1991, p. 94). Laosa (1981) identified fundamental learning processes as falling into two categories, stimulation and reinforcement. Within the stimulation construct, motivating factors are 'verbal attempts to elicit the child's interest and cooperation by suggesting to the child that the task would be a rewarding experience or by promising external rewards' (Walberg, 1991, p. 100).

Numerous researchers have suggested that motivation has a significant influence on students' learning (Adar, 1969; Brophy, 1987; Hofstein & Kempa, 1985; Kempa & Diaz, 1990a; 1990b; Maehr & Midgley, 1991; McCombs, 2000; Trumper, 1995; Walberg, 1991). It is of great concern that students enjoy, achieve and behave more appropriately in certain classes and for particular teachers. Hargreaves (1975) affirmed that 'when pupils move from an integrative to a dominative teacher (or vice-versa), marked changes in their behaviour occur' (p. 116). Too often students become disheartened by sarcastic, belligerent or apathetic teachers' comments. The consequences of teachers' insensitivity or the lack of assistance they provide for their students, cannot only be detrimental to student learning, but can hinder or suppress student motivation.

Teachers must be answerable to any criticism that suggests that the activities within the classroom may not be stimulating an active learning environment. Osborne (1997) believed that 'years of effort to promote public understanding and interest in science can be murdered by a few dire science lessons' (p. 48). Poliakoff (1998) viewed that the difficulties associated with motivating science students are due to the fact that 'practising scientists are often faced with the problem of how to communicate with school children' (p. 51). Solomon (1987) stated that 'the social scene makes an essential difference to the learning situation (p. 63). Cook (1997) asserted that 'poor teaching can have the effect of motivating students to learn for themselves' (p. 28). Resorting to this form of self-tuition can result in inaccurate learning and opens the door for student misconception of scientific facts.

The role of the teacher is to ensure that learning is personally meaningful for the students and that the associated teaching strategies encourage prolonged student interest in a topic. Teacher interpersonal behaviour can be viewed as being responsible for creating a motivating learning environment, 'a major source of sustained intrinsic motivation is the positive emotional experience that derives from meaningful learning' (Novak & Gowin, 1984, p. 103). When learners perceive learning to be interesting, fun, personally meaningful and relevant, and the context supports and encourages personal control, motivation to learn and self-regulation of the learning process occur naturally (Anderson & Lee, 1997; McCombs & Whisler, 1989).

Therefore, if students are taught by teachers who possess a genuine desire to promote a positive, warm and motivated learning environment, they should enjoy their learning experiences. Brophy (1987) recognized the fact that teachers should be active socialization agents capable of stimulating student motivation to learn. However, students' prior experiences in classrooms with teachers who possess a variety of teaching styles, must have some impact on determining the level of motivation experienced within the same classroom (Meece, Blumenfeld, & Hoyle 1988).

Damico and Roth (1994) examined students who wanted to remain in school compared to those who opted to drop out. The study revealed that, adults who treated students in positive ways, had high expectations and communicated joint responsibility for learning were instrumental in keeping them in school. Ultimately then, it is teacher interpersonal behaviour that has an enormous influence on whether students exude enthusiasm for classroom activities or despise all learning experiences.

Deci and Ryan (1985) researched the impact of teachers possessing autonomy orientation rather than control orientation; and concluded that if subjected to such an approach to teaching, the students will demonstrate greater intrinsic motivation and self-regulation. Thus, teaching strategies must be somewhat flexible to cater for individual student personalities and their needs. McCombs (2000) believed that students should be encouraged to take responsibility for regulating their own learning and for being self-determined and autonomous learners. Students also need to find learning personally meaningful to become engaged in valuable learning experiences (Deci & Ryan 1991; McCombs, 1991, 1994). Ornstein (1993) averred that teachers who emphasize the personal and social development of the learner are able to foster motivation and sustainable learning.

Oldfather (1991) attested that students' impulses to learn, stem from activities that promote student opinion, learner choice and self-expression, thus, promoting higher levels of intrinsic motivation. Hargreaves (1975) investigated types of teacher personality that students respond to and stressed that teacher background, training, attitudes, needs and personality are major influences on the ways in which teachers perceive and perform their role. Consequently, teachers' perceived interpersonal behaviour has some influence on students' level of motivation.

Not only does teacher interpersonal behaviour have a direct affect on student motivation, but it can also determine high quality and valuable learning. Good (1983) acknowledged the fact that there is considerable variation in teacher behaviour within classrooms. Students interpret this variation in a number of different ways and therefore, respond to their own learning accordingly. Individual student perceptions of classroom environment can therefore determine the intrinsic motivation level and their own work ethic.

3.5 RESEARCH STUDIES ON STUDENT MOTIVATION AND LEARNING

Numerous studies have assessed the impact that motivation has on the student's ability to learn. In fact, Kempa (1993) asserted that motivation could be viewed as a precondition of learning science. An overview of pertinent quantitative studies supports the theory that has been forwarded earlier in this chapter. More specifically, studies here have been evaluated to determine their significance in assessing the importance of a motivated classroom environment and one that encourages participation. Rinne (1998) believed that effective teachers are able to portray the intrinsic appeals of lessons to their students. It is interesting to note that many researchers believe that motivation changes very little over time in tertiary courses (Newstead, 1992). The studies highlighted below are qualitative and quantitative research findings that support the need to engender student motivation in order to strengthen learning.

3.5.1 Qualitative Studies

Kempa (1993) stressed that sustaining students' motivation in science may be critical for 'ensuring a positive response by the learners to the instruction to which they are exposed' (p. 13). Elton (1996) produced a theoretical analysis of the affect that assessment has on motivation. The analysis examined the strategies designed to guide students' learning and scrutinized the validity of Herzberg's theory of motivation in relation to Maslow's hierarchy of needs. He examined Herzberg's results in terms of the distinction between negative satisfiers and dissatisfiers. A significant focus of the study exposes situations of conflict between students' high intrinsic motivation and their teacher's failure to provide extrinsic motivation. The most important extrinsic factor affecting student motivation was exam preparation, and the dominant intrinsic factor affecting student learning was found to be subject interest and its flexibility in different learning environments.

Napier and Riley (1985) discovered that the highest correlate to achievement in science was student motivation. Rennie (1990) observed that 'by the age of fifteen years, students have settled into regular patterns of classroom engagement and participation in learning tasks' (p. 165). She elaborated on the role that students play in willingly involving themselves purposively in classroom tasks. Nicholls (1983) identified three kinds of motivational orientations that students appear to employ in the classroom that determine their behaviour. Students can be 'task-involved, ego-involved or extrinsically involved' (p. 182). Task-involved students are intrinsically motivated and value their learning; ego-involved students are more concerned with performance than learning and usually apply a minimal amount of effort in class and rely on rote learning. Extrinsically motivated students are encouraged by the need to attract teacher approval and rewards.

Rennie (1990) conducted effective qualitative studies to highlight how students' participation levels differed in different classrooms. She assessed six students who were representative of groups of students with similar quantitative patterns of engagement. The classroom observations of students interacting with the teacher and with other students provided the means for constructive conclusions to be drawn that supported the quantitative research. The motivational patterns and classroom interactions of students were observed and dialogues were presented that signified a variety of learning outcomes.

3.5.2 Quantitative Studies

Adar (1969) identified four motivational patterns that students display when learning science, namely, achievement, curiosity, conscientiousness and sociability. Kempa and Diaz (1990a) devised and validated a 60-item, five-point response questionnaire that was based on Adar's work. Kempa and Diaz (1990a; 1990b) conducted a comprehensive study involving 15-year-old Spanish students and drew pertinent conclusions regarding students' motivational traits and their preferences for different types of instructional techniques in the science classroom. In general, they discovered that curiosity motivation in students influenced their desire for discovery learning; students with a high degree of conscientiousness motivation prefer formal modes of teaching and well-directed instruction and students who possess are high level of sociability motivation are partial to group work in science.

Trumper (1995) conducted a study that utilized the same questionnaire that assessed high school students' motivational traits in science. The 944 students involved in the study were from seven secondary schools in Israel. The Cronbach alpha reliability coefficient was used to test the reliability of the four motivational scales each comprising 15 items. The 'sociable' scale had a low reliability value of 0.53 compared to the other three scales that ranged between 0.77 and 0.79. Thus, the results concluded that students were sociably motivated by classroom environment; 'the mean score measuring students' 'sociability' trait is significantly greater than all others ($p<0.001$)' (Trumper, 1995, p. 510). Also concluded by using the t-test was the fact that 'the mean score measuring the 'achieving' trait is significantly greater than the mean scores measuring the 'curiosity' and 'conscientiousness' traits' (Trumper, 1995, p. 510).

Overall, he found that 77% of students were assigned to one or a combination of two motivational traits in science, and similar results were obtained when calculations were analysed for each grade. This result indicated that 'motivation to learn science relies generally on more that one source' (p. 508). The correlation between the motivational traits was stated as being largely independent of each other by using the Pearson correlation coefficient.

A notable motivational study administered by Uguroglu and Walberg (1979) identified 200 correlations between motivation and achievement. Also Napier and Riley (1985) found that the highest correlate to achievement in science was student motivation. A more recent study conducted by Wu and Tuan (2000) investigated students' motivation in Taiwan. The study reported on factors that influenced the learning motivation of ninth grade physical science students. The study comprised 41 male students who possessed moderate abilities in science. Students were observed and interviewed in relation to their motivation toward learning physical science and their responses to a motivation questionnaire, involving five scales: achievement motivation, affiliation motivation, self-confidence, elaborating orientation and locus of control.

This questionnaire collected data about student motivation and their perception towards their physical science class. A significant proportion of this study involved reporting qualitative data obtained from the teacher and the students. Observations included the students being dependent on teacher-directed instructions, particularly in relation to note-taking and memorizations skills. Students' goals were directed by test scores and failure was due to lack of effort. The means for students' various motivation in learning physical science ranged from 2.32 (elaborating orientation) to 3.26 (locus of control). The results indicated that students considered that their success in physical science was 'based on their efforts rather than on outside forces' (Wu & Tuan, 2000, p. 344).

In summary, the study concluded that teaching methods, in particular, laboratory work stimulated students' motivation in learning physical science; the teacher's variety of rewarding methods influenced students learning, but also had the tendency to foster performance goals rather than mastery goals; parents' caring and modelling influenced students' motivation; and entrance examinations were a dominant factor in motivating students in Taiwan. Unfortunately, the study highlighted the fact that these students were not interested in understanding acquired knowledge, rather memorizing it for a test, therefore, being deficient in constructing scientific knowledge. Thus, they had achievement motivation, but lacked elaboration motivation. The study emphasized the fact that students will develop a higher motivation to learn if the teacher provides 'pleasant and non-pressuring learning activities and contexts' (Wu & Tuan, 2000, p. 347).

Rennie (1990) conducted a study in two science classrooms that revealed that 'students' patterns of participation were associated with their different motivational orientations' (p. 183). The study also identified that each class as a group, had a pattern of behaviour that was dependant upon the teachers' way of structuring and sequencing the activities in a lesson, and that off-task behaviour was related to the managerial style of the teacher. In particular, the study demonstrated how students' classroom behaviours could be interpreted in terms of how students participate in the lesson, their attitude towards science and their inferred motivational orientations. Results indicated that students' patterns of behaviour were very different in the two classrooms studied and this was primarily determined by the teaching and managerial styles of the teacher. Overall, the study provided a plethora of information that enabled teachers to reflect on ways that they can enhance the amount and quality of student participation in class. One teacher emphasized the need to provide real life examples and anecdotal evidence to support the students' understanding of the knowledge component of the course. The instructional manner of both teachers varied, and in-turn the effectiveness on students' engagement was noted.

The study highlighted the fact that the attitudes and self-perceptions that students have about science and about their ability are likely to affect the way that they use their time in the classroom. In particular, the three attitude scales, Enjoyment, Importance and Facility had coefficient alpha reliabilities of 0.93, 0.93 and 0.78 respectively' (Rennie, 1990, p. 180). Thus the students found science enjoyable, they found the topics being covered relevant and important, and perceived that science was easy to understand. Quantitative results regarding students' attitudes to science and perceptions about their ability indicated that generally students with positive attitudes had higher achievements. Furthermore, students with higher levels of time-on-task behaviour also generally have positive attitudes' (Rennie, 1990, p. 181).

It became obvious from Rennie's work that students' motivational orientations were associated with patterns of participation in the classroom. This in fact appeared to be determined by the teacher's ability to structure the lesson effectively. The study alluded to the fact that ultimately the student determines his or her own level of capability to learn. Good and Power (1976) emphasized that students' levels of engagement vary and are not always going to be catered for by teachers. Fraser and Tobin (1989) even suggested that teaching effectiveness might be inhibited by teachers' lack of familiarity with their knowledge base. They also stressed that the teachers encouraged students to be actively involved in classroom activities, managed their classes well, focused on student understanding, and maintained classroom environments that were conducive to learning. Thus, Fraser and Tobin's (1989) study challenged teachers to become more aware of students' interactions and engagement levels, and to direct lessons to challenge students' cognitive skills.

Another study that contributed to understanding student motivation and classroom learning environment was conducted by Huang and Waxman (1994). They compared motivational and socio-psychological variables between Asian-American and Anglo-American students in mathematics classes in the USA. Most findings indicated that Asian-American students' success could be attributed to their parents' high expectations. The study coordinated the use of three instruments to answer three research questions that related to: students' perceptions of their mathematical learning environment; motivational differences in Asian-American and Anglo-American students; and any differences in students' motivation and perceptions of learning environment according to their gender and grade level.

The instruments used included: the *Multidimensional Motivational Instrument* (MMI) that measured achievement motivation, academic self-concept and social self-concept, the two scales from the Classroom Environment Scale (CES) namely Involvement and Affiliation; and the *Instructional Learning Environment Questionnaire* (ILEQ) that contained the Satisfaction and Parent Involvement scales.

The reliabilities of six scales were tested using the Cronbach alpha coefficient. The values ranged from 0.55 to 0.83 and mean correlations between scales ranged from 0.14 to 0.63, indicating adequate internal consistency reliability and discriminant validity.

In general, this study highlighted the fact that there were significant differences by student ethnicity, gender and grade-level on motivation and perceptions of learning environment. Although similar results were observed for motivation levels and positive observations were recorded for perceptions of classroom, the Asian-American students were found to have greater pride in their work and higher expectations of themselves. It was also significant to note, that the higher the grade level, the less involved students appeared to be with their learning. Also, students' achievement motivation and perceptions of their learning environment declined as the grade level increased. The results also suggested that as the content of the course became more difficult, students lost interest in learning.

Bolte (1994) conducted a significant motivational study that was designed to assist teachers in analysing their own instructional techniques. Researchers inferred that learning climate in German schools might not be considered as important due to the fact that 'it may be too time-consuming to evaluate' (p. 182). With this criticism in mind, Bolte (1994) developed a questionnaire that assessed the motivational aspects of learning climate. It was a functional questionnaire that was primarily based on the *Kieler Motivational Learning Climate Questionnaire* (KMLCQ) and was divided into six dimensions, namely, *Satisfaction, Comprehensibility/Requirements, Subject Relevance, Students' Opportunities to Participate, Class Cooperation, Individual Student's Willingness to Participate.* Significant explanatory statements were forwarded for each dimension including the suggestion that 'every effort of the teacher to teach effectively fails if students do not try to learn for themselves' (Bolte, 1994, p. 183). Thus, creating an acceptable classroom learning environment is essential, however, every effort must be made by students to involve themselves in and be accountable for their own learning.

Researchers have identified three important considerations in relation to motivational processes in the classroom and classroom climate. Firstly, there should be an emphasis on the importance of students' opinions in relation to their actual and preferred classroom (Fraser & Fisher, 1983). Secondly, motivational attitudes must be assessed in relation to specific situations. The final consideration is to create an awareness of the suitability of such questionnaires for teachers' self-reflection.

This study by Bolte (1994), involved the use of three student and three teacher questionnaires that were based on the same six dimensions. They included 25 items and were recorded on a seven-point rating scale. The sample included 1,027 students from 53 German classrooms and Cronbach reliability coefficients ranged from 0.46 to 0.77 for the *Ideal* version, 0.62 to 0.86 for the *Real* version and 0.69 to 0.86 for the *Today* version. The analysis proved that the questionnaire was theoretically sound and extremely useful in formulating a good understanding about motivational learning climate. It also provided an avenue for teachers to reflect on their teaching methods and invited them to create ways in which students would like to learn chemistry.

Pintrich and de Groot (1990) conducted a study that examined relationships between motivational orientation, self-regulated learning and classroom academic performance. An analysis of self-efficacy and intrinsic value was vital in order to establish if there was a relationship between cognitive engagement and performance. This study also identified the fact that student achievement is not only determined by the knowledge of cognitive strategies, but the manner in which students use strategies to enhance their own learning (Pintrich, 1988). Although there is evidence to suggest that classroom environments enhance motivation, students' perceptions of their classroom coupled with their motivational beliefs towards learning, also have an important effect on cognitive engagement and subsequent learning.

They proposed a model that revealed three components of self-regulated learning that assist in determining how personal characteristics of students are related to their cognitive engagement and achievement. The components are expectancy (students' beliefs about their ability), value (how students rate the interest of a task) and affective (students' emotional reaction to a task). A sample of 173 students responded to a 56-item self-report questionnaire the *Motivated Strategies for Learning Questionnaire* (MSLQ) on a seven-point Likert scale. The MSLQ had been adapted from various instruments and attempted to measure student motivation, cognitive strategy use, metacognitive strategy use and management of effort (Pintrich & de Groot, 1990). Three motivational factors, self-efficacy, intrinsic value and test anxiety were identified from the implementation of the MSLQ.

In relation to motivational and self-regulated learning, higher levels of self-efficacy (r=0.33) and intrinsic value (r=0.63) were correlated with higher levels of cognitive strategy use. It was also interesting to note, that self-efficacy for boys was higher than it was for girls, and that self-efficacy was positively related to student cognitive engagement and performance. Although there did not appear to be any relationship between self-efficacy and performance, improving self-efficacy may lead to the use of more cognitive strategies by students. Similarly, students' intrinsic value for schoolwork does not guarantee academic achievement, but it 'may lead to more cognitive engagement in the day-to-day work in the classroom' (Pintrich & de Groot, 1990, p. 37). Pintrich and de Groot (1990) drew valid conclusions from this research; in particular, student involvement in self-regulated learning is closely tied to students' efficacy beliefs about their capability to perform classroom tasks and to their beliefs that these classroom tasks are interesting and worth learning.

This section of research illustrated the vital impact that motivation has on student learning. It is evident thus far, that motivated student behaviour must be nurtured by positive learning experiences in the classroom. A high level of commitment by teachers is essential to create affable classroom environment conditions, engender personal responsibility for learning and result in appropriate and effective behaviour. Various factors have been identified that are influential in determining students' patterns of participation and their motivational orientation. Students' perceptions of their classroom environment and teacher interpersonal behaviour have been alluded to as important determinants of student motivation. Factors affecting students' attitudes towards science will now be analysed with the intention of identifying which factors ultimately contribute to sustaining students' enjoyment of their science lessons.

3.6 STUDENTS' ATTITUDES TOWARD LEARNING SCIENCE

Numerous studies have highlighted the significance that students' attitudes play in determining active learning and enjoyment of science lessons. Fraser (1981) examined attitudes by constructing the Test of Science-Related Attitudes (TOSRA) which was designed to measure seven distinct attitudes by secondary school students to science. The effect that learning environment has on shaping students' attitudes in science classrooms has been analysed in a variety of settings. These include the initial use of the *Environmental Science Learning Environment Inventory* (ESLEI) (Henderson, Fisher, & Fraser, 1998) and the CUCEI, used by Nair & Fisher (2001) explored students' and instructors' actual and preferred perceptions of their classroom learning environments at a secondary and tertiary level. The reliabilities of the scales ranged from 0.73 to 0.94 and it was concluded that secondary school students viewed their learning environment in a more positive light than tertiary students.

Bhushan (1991) utilized the LEI to assess learning environments and teacher attitudes in Canada. Hansen (1999) examined student interest in science education; Schibeci (1984) outlined the importance of science attitude objectives; George and Kaplan (1998) and Papanastasiou (2002) included an emphasis on the role that parents and teachers have and the impact that school climate has on influencing students' attitudes; Mattern and Schau (2002) and Reynolds and Walberg (1992) assessed gender differences in science attitudes and achievement; Freedman (1997) highlighted the impact that laboratory work has on attitude toward science and achievement towards science knowledge. Thus, a wide range of issues have been addressed in order to ascertain what underlying factors determine the attitudes that students develop towards science.

This section addresses the following issues, the importance that learning environments have on students' attitudes in science and the impact that they have on determining enjoyment, learning and achievement. Also a variety of factors that can influence students' attitudes and the role of teacher interpersonal behaviour in determining students' attitudes towards science will be forwarded. A brief analysis of significant studies will highlight major findings that have influenced researchers thinking about students' attitudes in the science classroom.

3.6.1 The Significance of Students' Attitudes Toward Science

Ultimately, it can be reasoned that if students are stimulated by how science lessons are presented to them, then their attitude towards the subject will reflect a willingness to be involved in the learning process. Thus a classroom with minimal friction would surely positively influence students' attitudes. Copious amounts of research have indicated that teacher interpersonal behaviour and learning environments (Brekelmans, Wubbels, & Levy, 1993; Fraser & Walberg, 1991) have had a significant impact on student attitudes. Therefore, the manner in which teachers conduct themselves and deal with each student individually, must have some influence on students' attitudes towards the learning process. Koballa (1988) suggested that 'affective variables are as important as cognitive variables in influencing learning outcomes' (p. 115). It is essential to understand that classroom environment coupled with the school environment influence students' attitudes towards their work.

Researchers have ascertained that 'students' attitudes can also be determined by their desire to achieve and others argue that it is in fact that achievement actually determines students' attitudes' (George & Kaplan, 1998, p. 93). Keeves and Alagumalai (1998) believed that 'attitudes and values towards science are important outcomes in science education. Values related to science have a clearly recognizable influence on both science achievement and participation in the study of science and in the choice of career. Likewise, students' attitudes also influence both achievement and participation in science' (p. 1238). The use of various instruments has verified the presumptions regarding the fact that students' attitudes can influence their learning of science.

It is essential that science educators define the term attitudes, in order to assist them with understanding students' classroom behaviours. Attitudes can be learned from experiences and can shape students' behaviour in the classroom. Neathery (1997) believed that students' attitudes to science affect their level of participation. It can be assumed that students' actions in a classroom reflect the feeling they have towards a particular activity. These attitudes because they are learned, can also change over time. Allport (1968) stated that an attitude is a 'state of readiness for mental and physical activity' (p. 60). Students frequently seek reasons for having to learn science and teachers can be equally challenged by justifying the relevance of a topic. Lin (1998a) believed that integrating history in science teaching could facilitate student conceptual understanding of chemistry. Morrel and Lederman (1998) postulated that student attitudes towards classroom science appear to be shaped by certain factors: teachers, learning environments, self-concept, peers and parental influence. Anderson and Lee (1997) viewed effective science instruction as 'one that addresses students' personal agendas and commitments, as well as their conceptions and learning processes in science' (p. 720). However, Ausubel (1968) believed that the major factor determining learning is the 'level of prior knowledge students possess' (p. vi).

Tobin, Butler-Kahle, and Fraser (1990) stated emphatically that 'if students are to benefit from a science program, it is essential that learning tasks are potentially interesting and challenging' (p. 8). In agreement with this theory are George and Kaplan (1998) who believed that 'science activities have a significant direct effect on science attitudes' (p. 93). The relevance of content and the method of delivery in science lessons are of paramount importance when endeavouring to promote valuable learning. The curiosity for learning science essentially can be aroused by teachers who enthusiastically present their wealth of knowledge to students in a relevant and interesting way. Deci, Nezlek, and Sheinman (1981) deduced that 'students' curiosity about subject matter is aroused when teachers are willing to assist and encourage them. Students are receptive to science teachers who are enthusiastic about the subject they teach, are well-equipped with their content and can transmit positive attitudes into everyday learning. It is disturbing to report that the ETS (1991) concluded that 61% of 8^{th} grade students and 76% of 12^{th} grade students reported that their teachers lecture them in science several times a week.

Other general findings by education researchers regarding student interest in science include those forwarded by Klopfer (1971) who suggested that interest could be measured by assessing students' involvement in activities that they can complete by themselves. George and Kaplan (1998) believed that 'attitudes are learned and therefore, the influence of others is a key factor in the development of students' attitudes towards science' (p. 73). Papanastasiou (2002) stated that the 'classroom variables that affect students attitude and achievement include the curriculum, teacher quality, teacher personality and a variety of classroom environmental factors' (p. 72). In agreement with this comment are Morrell and Lederman (1998) who also see parental influence and self-concept as significant contributors to attitudes formed by students.

Schibeci (1984) has extensively researched attitude in science and has drawn a few interesting observations. He concluded that attitudes are affected by science programs, home background and gender. He deduced that 'students' attitudes to biological science appear to be more favorable than to physical sciences and that attitude to science appears to decline as school students move to higher grades' (p. 46). Willson (1983) found that success in science reinforces positive attitudes. However, some studies have suggested that attitudes towards science influences achievement (Freedman, 1997). Reynolds and Walberg (1992) concluded that science achievement influences science attitudes. It is debatable which theory is more acceptable, but what is certain is that, 'the quality of science education correlates directly with the quality of instruction' (Papanastasiou, 2002, p. 73).

Teacher Interpersonal Behaviour: Its Effect on Students' Attitudes to Science

It has become more evident throughout this research that teacher interpersonal behaviour can have a long-term impact on the learning of science. Numerous studies have also promoted interpersonal behaviour as being responsible for determining attitudinal and cognitive achievement. Brekelmans, Wubbels, and Levy (1993) concluded that authoritative and directive teachers had the highest attitude scores and teachers who were drudging, uncertain/aggressive and repressive produced students with the worst attitudes. They also deduced that the Cooperation scales for the model of teacher interpersonal behaviour are positively related to students' attitudes.

Rickards and Fisher (1999) used the concept of teacher interpersonal behaviour to determine associations between cultural backgrounds of students and their attitudinal and cognitive achievement outcomes. In particular, Rickard and Fisher's study identified significant positive associations between three scales of the QTI, namely, Leadership, Helping/Friendly and Understanding and students' high attitude scores.

Wubbels (1993) found that students' perception of interpersonal teacher behaviour was responsible for 70% of the variability in student achievement outcomes and 55% for attitude outcomes. Brekelmans and Créton (1993) asserted that 'teachers with about ten years of experience have the best interpersonal relationships to promote student achievement and positive attitudes (p. 102).

Fisher and Rickards (1996) also investigated the relationship between teacher interpersonal behaviour and student attitudinal outcomes in mathematics. This was a distinctive study that encompassed a student attitude survey, Attitude to This Class scale, based on the TOSRA (Fraser, 1981). The results were calculated by identifying correlations between each QTI scale and each student attitude. Research has identified the fact that student perceptions of teacher interpersonal behaviour were related to their achievement and their attitude to class (Rickards & Fisher, 1996).

Interestingly, this study revealed that the greatest contribution to attitude occurred when teachers displayed leadership, helpful/friendly and understanding behaviours and were less strict, dissatisfied and admonishing. In general, females perceived teachers' interpersonal behaviour in a more positive frame of mind than did males. Fisher and Rickards (1996) also concluded that students' attitude scores were higher in classrooms where students perceived that teacher interpersonal behaviour reflected leadership and helpful friendly behaviours and lower in classrooms where teachers displayed strict and dissatisfied behaviours. The Attitude to This Class scale used in such studies as these was used in the research described in this thesis, in an endeavour to investigate associations between teacher interpersonal behaviour to student attitudes.

3.6.2 Research into Teacher Interpersonal Behaviour: The Effect on Students' Attitudes

Various studies have alluded to the fact that not only does teacher interpersonal behaviour impact on students' levels of cognitive achievement, it affects students' attitudes towards science. She and Fisher (2002) used the *Teacher Communication Behaviour Questionnaire* (TCBQ) to support this theory and from their findings, stated that 'positive relationships were found between students' perceptions of their teachers' communication behaviours and their attitude toward science' (p. 63). Koul and Fisher (2004) studied the impact that teacher-student interactions had on students' attitudes towards science classes using single (r) and multiple correlation analyses (β). Multiple correlation (R) was 0.39 between the set of QTI scales and attitudes to science classes. It was found that the Leadership and Helping/Friendly scales were positively and significantly associated with attitudes to science classes. Stolarchuk and Fisher (1998) studied the effectiveness of laptop use on students' attitudinal and achievement outcomes. In this instance, the multiple correlation (R) of 0.63 suggested that the association between laptop students' perceptions and teacher-student interpersonal behaviour in science classrooms, measured by the QTI and students' attitude to science was strong. Fisher and Stolarchuk, (1998) also researched the effectiveness of laptops in science classrooms by analysing the impact the computers had on students' perceptions of classroom environment using the

Science Classroom Environment Survey (SCES); students' attitudes using TOSRA and achievement using the Test of Enquiry Skills (TOES).

3.7 RESEARCH STUDIES ON STUDENTS' ATTITUDES TOWARD SCIENCE

All students certainly have the ability to learn, thus the teacher should be the catalyst who endeavours to provide a variety of learning experiences and an environment that promotes positive attitudes in the classroom. It is a well-known fact that students learn differently. The Myers-Briggs Type Indicator (Briggs & McCaulley, 1993) accurately determines learning approaches that students prefer based on student personality. Cook (1997) asserted that knowing the student 'type' can assist teachers in developing more relevant activities geared towards better acquisition of knowledge and therefore, increase learning. It is also a useful tool in helping teachers to reflect on their teaching practice. Thus, the readiness and willingness of students to be involved in the learning of science can be due to a variety of factors. It is with this thought in mind that the uses of instruments that assess students' attitudes in the science classroom are addressed here.

Numerous instruments have assessed students' attitudes towards science; the *Minnesota Teacher Attitude Inventory* (MTAI) (Cook, Leeds, & Callis, 1951); the *Minnesota School Affect Assessment* (MSAA) (Johnson, 1974); TOSRA (Fraser, 1981); the *Wareing Attitude toward Science Protocol* (WASP) (Wareing, 1982); *Science Attitude Questionnaire* (SAQ) (derived from TOSRA); *Scientific Orientation Test* (S.OR.T) (Meyer, 1995), *Science Attitude Instrument* (SAI II) (Moore & Foy, 1997); *Chemistry Attitudes and Experiences Questionnaire* (CAEQ) (Dalgety, Coll, & Jones, 2003); the *Colorado Learning Attitudes about Science Survey* (CLASS) (Adams, Perkins, Dubson, Finkelstein, & Wieman, 2004); *Attitudes Toward Biology Scale* (ATBS) (Chuang & Cheng, 2003); *School Attitude Assessment Survey-Revised* (SAAS-R).

An inordinate amount of research has confirmed the importance of identifying factors that can influence students' attitudes towards science. It is essential that such valuable research infiltrates through to teachers who can use it to reassess their approach to the classroom routine. Some important findings mentioned below have identified the impact that students' attitudes can have on learning.

The WASP measured interest in the history of chemistry (Lin, 1998a) and revealed high consistency of the measurement of the instrument. The Cronbach alpha reliability for pre and post tests ranged from 0.87 to 0.92. The study noted that there was significant evidence to suggest that the teaching of the historical concepts of chemistry being integrated into the teaching of chemistry resulted in positive student attitude change. The CLASS was designed to measure students' attitudes and beliefs about learning physics. Results indicated that there were positive correlations between student attitudes and conceptual learning gains. It can be concluded from this particular study, that students who adopted a more positive outlook towards the science course, grasped a better acquisition of knowledge.

Johnson and Johnson (1991) acknowledged the development of an Australian version of the MSAA that was used to develop three useful instruments: *The Learning Preference Scale for Students* (LPSS), *The Learning Preference Scale for Teachers* (LPST) and *The Classroom Learning Atmosphere Scale for Secondary Schools* (CLASSS) have all been used effectively to analyse learning styles and students' attitudes. The S.OR.T measured interest in and attitudes towards science. Various researchers, including Harty, Samuel, and Beale (1986) found that a combination of science interest scores were reliable. The SAI II is another reliable instrument that assesses students' attitudes recording 0.78 for the Cronbach reliability coefficient.

Williamson and Grankowski (1996) were interested in measuring the attitude and motivation of tertiary students towards construction courses. The study highlighted the importance of classroom climate as a predictor of students' attitudes towards science. The study was based on My Science Class (MSC) (Sidlik & Piburn, 1993). One of their major findings was as students' perceptions of their ability increased, so did their attitude to the task. The use of the College and University Classroom Environment Inventory (CUCEI) by Nair and Fisher (2001) revealed that tertiary students were more dissatisfied in their attitude towards their science courses compared to secondary students. Another study that assessed attitudes of tertiary students was conducted by Yaxley, Fisher, and Fraser (2000). They developed and used the *College Science Classroom Environment Survey* (CSCES) that illustrated a significant relationship between classroom environment and student attitudes. In particular, ‘an overall 41% of the variance in students’ attitudes to their classes could be attributed to their perceptions of their learning environment’ (Yaxley, Fisher, & Fraser, 2000, p. 485).

Chidolue (1996) produced a study that found that there existed a ‘significant positive relationship between teacher experience, teacher locality and student attitude and achievement’ (p. 273). There was a strong message in this research that suggested that students’ attitudes are finely tuned to the attitude of their teachers. An interesting study conducted by Gibson and Chase (2002) assessed the long-term impact of the *Summer Science Exploration Program* (SSEP) on students’ attitudes and interest in pursuing science careers. The qualitative results indicated that ‘teachers’ instructional methods have an impact on students’ attitudes towards science’ (p. 702). Students also revealed that they are ‘willing to exert more effort in science classes if they are encouraged to express their interests by asking questions about the material being covered’ (p. 704). Bhushan (1991) deduced from his Canadian study using the MTAI that ‘teachers’ belief in greater pupil freedom and self-direction, which extends from and is facilitated by teacher involvement, is likely to decrease friction and apathy in the classroom’ (p. 253).

3.8 SUMMARY

This chapter has demonstrated that associations made between teacher interpersonal behaviour affect student motivation and students’ attitudes towards science. It not only provided an overview of two pertinent factors that influence student learning and enjoyment of science; student motivation and students’ attitudes, but it addressed motivational theory and students’ needs. Firstly, Maslow’s Hierarchy of Needs, Piaget’s Theory of Cognitive Development and Kohlberg’s Theory of Moral Development were briefly described. This information portrayed students’ needs as being formed and changed through multiple experiences and avenues in the classroom, including teacher interpersonal behaviour. Thus, these sections highlighted the need for teachers to develop empathy for students and to be aware of the wide array of students' needs that require attention on a daily basis. Factors that affect students' attitudes towards science included parental influence, gender differences, presence of adequate laboratory experiences and inevitably teacher interpersonal behaviour.

The strength of this literature review was the copious amount of documentary evidence that supported the theory of teacher interpersonal behaviour and its profound effect on student motivation and students' attitudes towards science. However, despite this extensive review, there was still a need to investigate potential relationships between teacher interpersonal behaviour and its direct affect on student motivation and students' attitudes towards science. This particular research certainly builds on previous studies acknowledged here, but it will be unique in that it identifies links between not only the factors mentioned in this chapter but also the powerful concept of self-efficacy (Bandura, 1977) as a determinant of student motivation and student learning. Presented in the next chapter is the theory that teacher interpersonal behaviour has a significant impact on students' self-efficacy.

CHAPTER 4

LITERATURE REVIEW: STUDENT SELF-EFFICACY AND ITS EFFECT ON STUDENT MOTIVATION AND ATTITUDE TOWARDS SCIENCE

4.1 INTRODUCTION

This chapter seeks to promote student self-efficacy as one of the most influential factors that affects students' motivation and attitude towards science. In this study, teacher interpersonal behaviour has been recognized as having an enormous impact on students' motivation towards learning and attitude towards science. Weiner (1990) suggested that:

> There should be a greater number of motivational investigations that are not linked with learning. There is an abundance of evidence that motivation influences a vast array of other variables, including affective experience, self-esteem, and so forth. Educational psychologists must broaden their nets to capture the richness of motivational impact. (p. 621)

This framework of thought prompted this study to also focus on the impact that teacher interpersonal behaviour has on student self-efficacy and, therefore, the effect on determining students' motivation and attitude towards science.

Students are primarily responsible for their level of engagement in classroom activities; however, student involvement in class activities can be attributed to a combination of factors. Individuals create self-perceptions of their ability and these views determine the goals they set for themselves. Bandura (1977) identified self-efficacy and social learning theory as having a significant impact on understanding motivation in the classroom. Self-efficacy is referred to as 'people's beliefs about their capabilities to exercise control over events that affect their lives' (Bandura, 1989, p. 1175).

Self-efficacy beliefs:

> Determine how much effort people will expend on an activity, how long they will persevere when confronting obstacles, and how resilient they will be in the face of adverse situations; the higher the sense of self-efficacy, the greater the effort, persistence and resilience. (Pajares, 2002, p. 5)

Self-efficacy acknowledges a person's belief that one can accomplish a certain goal. Thus, expectations can influence one's choice in resultant behaviour and the amount of energy exerted on a particular task.

4.2 SELF-EFFICACY

4.2.1 Social Learning Theory and Self-Efficacy

Albert Bandura is the most widely recognized theorist in relation to social learning theory and self-efficacy (Bandura, 1977; 1986; Bandura & Locke, 2003; Schunk, 1995). He suggested that success is the cornerstone of self-belief and, therefore, can determine one's level of achievement. Bandura (1986) viewed:

> Those who perceived themselves as highly efficacious are inclined to attribute their failures to insufficient effort, whereas those of comparable skills, but lower perceived self-efficacy ascribe their failures to deficient ability. (p. 395)

This important comparison assists in understanding the processing of students' interpretations of performance levels and expectations of oneself in the science classroom. Bandura (1986) asserted that students who possess low self-efficacy believe that situations are tougher than they really are and highly efficacious students focus their attention on overcoming barriers in their path. As previously outlined, students' self-efficacy can change. Schunk (1995) stressed that students who do not succeed, do not necessarily maintain low self-efficacy if they believe that they have the capacity to perform better. Their performance can be improved if they alter their level application for example, on set tasks. Thus, Pajares (1996) asserted that 'how individuals interpret the results of their performance attainments, informs and alters their environments and their self-beliefs, which in turn inform and alter their subsequent performances' (p. 543).

Bandura (1986) clarified the meaning of self-efficacy judgements as being concerned 'not with the skills one has but with judgements of what one can do with whatever skills one possesses' (p. 391). He also distinguished between judgements of personal self-efficacy from response-outcome expectations, stating 'perceived self-efficacy is a judgement of one's capability to accomplish a certain level of performance, whereas, an outcome expectation is a judgement of the likely consequence such behaviour will produce' (Bandura, 1986, p. 391).

It is, therefore, understood that judgements of efficacy determine the level of one's persistence. Thus, when a student judges their own capability of accomplishing a given task, their analysis has the potential to influence their thought processes and related emotions that can determine their performance. Bandura and Locke (2003) highlighted the fact that self-efficacy beliefs 'affect whether individuals think in self-enhancing or self-debilitating ways, how well they motivate themselves and persevere in the face of difficulties, the quality of their emotional well-being and their vulnerability to stress and depression, and the choices they make at important decisional points' (p. 87).

Martin (2003) stated that 'self-belief is one of motivation's most vital components' (p. 32). Thus, it can be argued that if a student's self-efficacy belief is low, then their motivation is also lowered. It has been deduced in this research that as students' self-efficacy is based on self-diagnosis of ability, students in the same classroom can interpret their environment quite differently due to prior classroom experiences. As students progress through adolescence, they become more vulnerable to issues regarding acceptance of self or self-belief, which has the potential to affect performance. Bandura (1997) believed that success can be determined by self-belief, thus, one's perception of their ability to succeed. Social comparisons by students in classrooms are inevitable, thus, students' levels of self-efficacy play an important role in motivating them to want to participate in classroom activities. Kurbanoglu

(2003) deduced that a strong link exists between attitudes and achieving self-efficacy (p. 637).

4.2.2 Social Cognitive Theory and Self-Efficacy

Perceptions of one's capabilities brought about by self-reflectiveness are central to Bandura's (1986) social cognitive theory of self-efficacy. He viewed self-efficacy as peoples' judgements or beliefs about their capabilities that determine performance in events that affect their lives. Bandura (1986) believed that one's self-beliefs determine thoughts and actions and that the way people think, believe and feel affects their behaviour. He believed that by reflecting on one's actions, individuals can self-evaluate and respond by changing how they think and their subsequent behaviour.

Bandura (1986) also believed that people formed their self-efficacy perceptions from four sources. Firstly, *mastery experiences* are interpreted as results of one's past performance. Thus, strong self-efficacy is formed when a person experiences previous success and in contrast, repeated failure lowers self-efficacy. Thus, previous experiences help to create efficacy beliefs. *Vicarious experiences* are formed by students when they compare themselves to peers whom they believe have similar expertise. This type of comparison enables students to model their level of self-efficacy against students who they believe they equate to academically.

The third factor that is believed to determine student self-efficacy is *verbal persuasion.* This technique is performed by teachers who endeavour to convince students that they have ability and skills to be able to succeed at a certain task. Thus, a teacher's ability to encourage students can influence the level of self-efficacy that a student acquires. It has been noted, that it is easier to weaken self-efficacy beliefs through negative appraisals than to strengthen them through positive encouragement. The final factor that can affect self-efficacy is the *physical and emotional state* of the student. Typically, students who are stressed and enter the classroom with a negative mindset would display more self-doubt and display low levels of self-efficacy. On the other hand, students who are optimistic, have the ability to generate higher expectations of themselves and ultimately acquire higher levels of self-efficacy. Thus, Bandura's social cognitive theory highlighted the fact that people are more likely to engage in tasks where success is imminent and less likely to pursue tasks where failure is most probable. Smist and Owen (1994) predicted that, if attitudes toward science and science self-efficacy can be improved, females in particular would be more inclined to pursue science careers.

Curriculum design can also determine the level of self-efficacy students acquire and display in the classroom. It has been explained in this research that students' self-efficacy levels may differ from class to class. It is, therefore, essential to taper the curriculum in order to encourage all students to involve themselves in active classroom learning. As highly efficacious students are more likely to be independent learners (Pajares, 1996), the curriculum needs to cater for a variety of learning needs and the varying levels of self-efficacy in the classroom. Jinks, Lorsbach, and Morey (2001) concluded that 'teachers need to provide small concrete experiences in the domain that requires self-efficacy enhancement. As success grows, so should the sophistication of the task' (p.4). They argued that students' progress may be hindered by the manner in which the course is structured. Thus, if learning is structured as a progression of steps, students may not feel intimidated by difficult content and will gradually build in competence and, therefore, their self-efficacy will be raised.

It is important to note that vicarious experiences infer that students are continually undergoing a method of self-monitoring. This technique of self-reflection can allow oneself to compare their results with a desired outcome level and, therefore, increase levels of personal satisfaction. Maddux (1995) believed that 'through the monitoring of self and situation, people develop beliefs not only about their current level of competence, but also beliefs about rate of improvement in competence' (p. 13). He also viewed self-efficacy as influencing cognition in four ways. Firstly, he revealed that levels of goal setting are higher for people who have strong levels of self-efficacy and they, therefore, commit to their goals with more determination. Secondly, self-efficacy beliefs influence one's strategies for attaining set goals. Thirdly, they influence the development of rules for predicting and influencing events. Finally, self-efficacy in problem solving influences the efficiency and effectiveness of problem solving.

4.2.3 Self-Efficacy and Human Functioning

Bandura (1997) concluded that self-efficacy beliefs determine one's functioning as a human being in that 'people's level of motivation, affective status, and actions are based more on what they believe than on what is objectively true' (p. 2). It could therefore be suggested that self-efficacy can also have a significant bearing on one's ability to acquire knowledge and utilize it effectively. Bandura (1994) highlighted four major psychological processes through which self-beliefs of efficacy affect human functioning. Firstly, there are *cognitive processes* that involve the visualization or prediction of beliefs about performance outcomes. Bandura believed that people who possess a strong perceived self-efficacy, the higher the goals they set for themselves and the more committed they are to achieving them. Thus, one utilizes cognitive processing of information in order to attain a standard, to focus on a goal and to direct one's judgments on how to achieve that goal.

Motivational processes are in operation when people set goals and plan their course of action based on their belief about their ability to achieve such goals. Bandura (1994) attested that self-efficacy beliefs contribute to motivation in several ways: they determine the goals people set themselves, how much effort and time they expend on a given task and their resilience to failure. Thus, those people with low self-belief will baulk and give up more easily when difficult situations present themselves. In comparison, people who possess strong self-belief will not allow testing situations to hinder their efforts they exert and inevitably their achievement. They view any difficulty as a challenge rather than a hindrance to their success and as a catalyst that promotes better performance.

Human functioning due to self-efficacy can be determined by *affective processes*. These processes are established by a person's beliefs in their coping abilities in stressful situations. People with low self-efficacy allow negative thoughts to control their levels of anxiety. They focus unnecessarily on their lack of coping mechanisms in potentially threatening situations and this can impede their level of functioning.

Finally, *selection processes* addresses the choices people make about their environment which can determine their life path and the subsequent activities they undertake. Thus, one who has a higher level of self-efficacy is more inclined to consider a wider array of career options before deciding on a set career. It is of interest to note, that if one's level of self-efficacy can determine career path, then that selected career may in fact shape one's life choices based purely on one's level of perceived self-efficacy at a particular time. Thus, it is essential that students are provided with opportunities in the school environment and the classroom that are designed to develop their cognitive skills, in order to develop high levels of self-efficacy.

In the family context, research by Caprara, Pastorelli, Regalia, Scabini, and Bandura (2005) stipulated that:

> the greater adolescents perceived their self-efficacy the more they reported open communication with their parents, the more accepting they were of their parents; monitoring of their own activities outside the home and the less inclined they were to get into escalative discord over disagreements. (p. 71)

It is understandable that if high levels of self-efficacy that are being encouraged in the home environment, then students may be more inclined to adopt a positive level of self-efficacy at school. Bandura (1997) professed that a stimulating and positive home environment directly affects a child's ability to interact effectively and subsequently, positively affects self-efficacy. Carter, Sottile, and Carter (2001) noted the positive impact that a supportive home environment had on a child's self-efficacy.

Significant conclusions have been formed in relation to Bandura's theory of self-efficacy and they provide valuable information for consideration by teachers. Bandura (1994) believed that students who are highly efficacious are those who possess a strong sense of intrinsic commitment when confronted with demanding tasks and who persevere when challenged. Due to their tenacity to succeed in any task they undertake, they become self-assured and less likely to be threatened by potential failure. Subsequently, they are less stressed and are more likely to achieve. In contrast, students who have low expectations of themselves tend to avoid exerting themselves and anticipate failure. Their perceived inadequacies cause them to focus on their inability or justify reasons why they will not succeed rather than striving to perform successfully. These less-efficacious students tend to lack perseverance and easily accept that their insufficient performance is due to lack of aptitude.

4.2.4 Teacher Impact on Student Self-Efficacy

As previously described in this research in relation to motivation theory, goal setting and self-efficacy are influential factors on student expectations and achievement (Pajares, 1996). Teacher credibility and respect are also important factors that can establish effective levels of student self-efficacy. Thus, teachers who possess a confident and self-efficacious manner surely have a significant positive impact on student self-efficacy. Schoon and Boone (1998) conducted valuable research on teacher self-efficacy. Brownell and Pajares (1999) deduced that teachers' self-efficacy beliefs also had a direct effect on teachers' perceived success in instructing mainstream special education students.

Bandura (1994) attested that efficacy about teaching capabilities can motivate students and enhance their cognitive development. Teachers can often unintentionally resort to negative strategies designed to entice students to focus on set tasks in class. However, Bandura believed that 'teachers, who have a low sense of instructional efficacy, favour a custodial orientation that relies heavily on negative sanctions to get students to study' (Bandura, 1994, p. 10). Schoon and Boone (1998) noted that teachers who possess negative attitudes towards science can pass such negative attitudes onto their students in class.

Bandura (1986) also revealed that efficacy beliefs vary between individuals and will actually fluctuate within an individual for different tasks when they have similar ability. Thus, if levels of self-efficacy are able to fluctuate then the role of the teacher becomes central to this issue. This study revealed that the manner in which teachers are able to influence students' self-efficacy can perhaps be determined by the classroom environment and teacher interpersonal behaviour.

It is the researcher's belief that teachers should be the catalyst for inciting students to strive for higher levels of self-efficacy in order to realize their potential, develop their confidence and ultimately improve their academic achievement. Receiving constructive feedback from teachers can provide significant efficacy information that a student relies upon to develop their self-belief. Just as self-efficacy levels can be raised, they can also be lowered, thus, teachers have an enormous responsibility to ensure that students' are provided for by creating an inviting classroom environment that nurtures their personal learning needs. Pintrich and Schunk (1995) postulated that students' self-efficacy decreases as they progress through school. Due to the fact that self-efficacy has the capacity to direct productive student learning, verbal comments by teachers coupled with their interpersonal behaviour can have a considerable impact on student self-efficacy over the years.

Bandura (1994) viewed the school environment as an agency for cultivating cognitive self-efficacy. He viewed the efficacy beliefs of schools as a whole are important in creating positive learning environments that are conducive to encouraging efficacious students. He identified 'teachers' interpretations of children's successes and failures in ways that reflect favourably or unfavourably on their ability, also affect children's judgements of their intellectual efficacy' (p. 9).

Bandura (1994) also believed that students with low self-efficacy tend to avoid difficult tasks, however, if they do attempt them they will give up more easily than students with high self-efficacy. In fact, he believed that staff belief systems can promote academic success and can directly control the climate of the school as a social system. He is quite critical of some processes in school that seek to enhance students' performances but can inadvertently demoralize students and lower their self-efficacy. He believed that situations such as 'ability groupings which further diminish the perceived self-efficacy of those cast in the lower ranks' (Bandura, 1994, p. 10) to be quite detrimental toward student progress. He stressed a need for self-comparison appraisal rather than social comparison where students compare their rate of progress to their personal standards rather than to the performance of others, thus, raising perceived capability.

As lifelong learners, students require cooperative learning structures that are less competitive. These structures should promote self-evaluation that enables students to set attainable goals and experience academic success. Teachers should then endeavour to provide accurate feedback to students about performance. Bandura (1986) emphatically stated that ‘the raising of unrealistic beliefs of personal competence only invites failures that will discredit the persuaders and will further undermine the recipient’s perceived self-efficacy’ (p. 400).

It was suggested by Kennedy (1996) that self-efficacy in science may affect science learning, choice of science, amount of effort exerted and persistence in science. When students are exposed to a variety of learning experiences in the science classroom, they are more inclined to be more responsive to acquiring knowledge and enjoying science. Bandura (1994) attested that self-comparison in a cooperative classroom environment where students work together has the ability to raise one’s perceived capability improve academic achievement compared to competitive environments. Schunk (1995) believed that the perception of progress strengthens self-efficacy and has the capacity to motivate students to continue to strive to perform. However, Bandura (1986) attested that high self-efficacy in one setting does not guarantee high self-efficacy in another.

4.3 RESEARCH STUDIES ON STUDENT SELF-EFFICACY

4.3.1 Significant Research on Self-Efficacy

Considerable research on self-efficacy has been conducted since Bandura introduced the concept, and significant findings have been established in a variety of fields. Noteworthy studies regarding self-efficacy and behavioural outcomes in society have been investigated (Bandura, 1982; Schunk, 1989). Areas of interest that have benefited from self-efficacy research include athletics, psychology, psychiatry, medicine and education. The plethora of topics include phobias, depression, smoking, teaching, academic achievement, goal setting, social comparisons, college students’ choice of majors and career choice.

In the area of teaching, Bandura (1986) concluded that, efficacy beliefs of teachers are related to their instructional practices and to various student outcomes. It is of some concern that teachers with low self-efficacy have a significant impact on students' cognitive development. Teacher self-efficacy has been investigated by numerous researchers. Loup, Ellett, Park, and Naik (1994) conducted a study that utilized four instruments to measure aspects of school learning environments. One instrument, the *Teacher Self and Organizational Efficacy Assessment* (TOSEA) (Loup & Ellett, 1993) measured the perceptions that teachers had regarding their ability to organize and devise courses to achieve set goals.

Numerous researchers have investigated student self-efficacy in a variety of academic settings (Carter, Sottile, & Carter, 2001; Haussler & Hoffman, 2000; Tiller, 1995). Pajares and Schunk (2001) were instrumental in identifying the relationship between self-efficacy, self-beliefs and school success. Pajares (1996) focused on examining self-efficacy beliefs in academic settings. He suggested that students' academic self-efficacy beliefs are correlated with motivation and students' academic performance and achievement.

It has been determined by numerous researchers that self-efficacy is an excellent indicator of behaviour and life choices. Betz and Hackett (1981a) identified the fact that women are under-represented in professional careers due to low self-efficacy. Hackett and Betz (1989) studied the effect that self-efficacy has on student motivation and future career choices and devised the *Occupational Self-Efficacy Scale* (OSES) (Betz & Hackett, 1981b). Zeldin and Pajares (2000) explored the impact that self-efficacy had on women's decisions to pursue careers in mathematics, science and technology. They concluded that vicarious experiences and verbal persuasions had a solid impact on women's self-efficacy beliefs and their career choice. Kennedy (1996) also believed that self-efficacy is an excellent indicator of career choice.

In the academic context, self-efficacy plays an important role in determining students' perceived ability. Pajares and Miller (1994) reported that mathematics self-efficacy had strong direct effects on mathematics problem solving. Bandura and

Schunk (1981) focused on examining whether perceived self-efficacy was related to accuracy of mathematical performance and to intrinsic interest in arithmetic. Hackett (1985) researched the relationship between mathematics self-efficacy and the choice of mathematics related college majors. Smist and Owen (1994) stated in relation to mathematics self-efficacy that males tended to consider their success as due to ability while females attributed their success to effort.

Schunk (1983) investigated the impact that progress self-monitoring had on students' self-efficacy and achievement in mathematics. He found that 'self-monitoring alone significantly increased students' time on task and mathematical achievement' (p. 90). There has been significant research that has focused on a variety of aspects in mathematics and self-efficacy (Betz & Hackett, 1983; Hackett, 1985; Hackett & Betz, 1989; Pajares & Kranzler, 1995; Smist & Owen, 1994).

Researchers have identified significant differences between levels of self-efficacy in females compared to males. Pintrich and De Groot (1990) identified the fact that females have lower levels of self-efficacy than males. Haussler and Hoffman (2002) revealed in their study that by adapting the curriculum to girls' interests, self-concept and achievement in physics was evident. Another gender related issue involving self-efficacy was conducted by Tippins (1991). Although she found that science self-efficacy was only slightly related to general student self-efficacy, it was apparent that males scored higher in science self-efficacy and were more inclined to choose to study elective science classes. Busch (1995) investigated gender differences in self-efficacy and attitudes towards computers in college students. This study also found that females had lower self-efficacy than males. In the context of computers, females had less computer experience in programming and less self-efficacy in relation to complex computer problems.

Other studies on self-efficacy include, Kurbanoglu (2003) found that there was a correlation between students' perceived self-efficacy for information and computer literacy. Kim and Lorsbach (2005) examined young children's perceptions of writing self-efficacy and compared students' perceptions to teachers' and researchers' perceptions. Pajares, Hartley, and Valiante (2001) conducted a detailed study that investigated writing self-efficacy. Welch (1995) investigated the self-efficacy of primary teachers in art education. Research self-efficacy was another topic explored in relation to facilitating training and career mentoring of graduate students (Forester, Kahn, & Hesson-McInnis, 2004).

4.3.2 Research on Science Self-Efficacy

Extensive research has linked self-efficacy to science achievement (Bandura 1997; Pajares 1996; Pintrich & De Groot, 1990). Tippins (1991) revealed that males scored higher than females in relation to science self-efficacy and this in turn prompted males to pursue more science subjects at school.

Science educators should encourage self-reflection in their students that will enable the students to identify their strengths and weaknesses in science. Thus, student evaluation of their potential may in fact determine the effort they exert and in turn determine achievement. Jinks, Lorsbach, and Morey (2001) declared that the primary aim of schooling should be that students grow towards greater self-determination. They elaborated on strategies that could be adopted by science teachers to increase student self-efficacy. Namely, provide opportunities for self-reflection, evaluation and discussion about their performances in science; incorporate problem-solving activities, involve students' opinions in relation to curriculum design; focus on relevant learning experiences that promote long-term growth; use student collaboration as a means of constructive learning; and utilize group work and individual focused learning experiences.

White (1998) acknowledged the *Project for Enhancing Effective Learning* (PEEL) which began in 1985 (Baird & Mitchell, 1986). The project drew the same conclusions that, students needed to be guided into reflecting on their learning. Teachers involved in the study highlighted the fact that any 'single method of teaching, no matter how good, if used alone soon became ineffective' (p. 8). They deduced that variety in learning experiences is essential if good learning behaviours and metacognition are to eventuate. PEEL provided numerous recommendations for teachers who wish to implement strategies for purposeful learning.

Smist (1993) highlighted the fact that males also scored higher than females in self-efficacy for laboratory skills in college chemistry, but overall, students did not experience an increase in self-efficacy in chemistry. Another significant study conducted by Kennedy (1999b) compared three measures of self-efficacy in the areas of maths, science and self-regulated learning. The study demonstrated correlation between science and maths self-efficacy and adhered to Bandura's (1977) theory regarding domain specific self-efficacy. Other noteworthy research in the area of science self-efficacy includes (Kennedy, 1999a; Ritter, Boone, & Rubba, 2001).

4.3.3 The Development of Self-Efficacy Instruments

Self-Efficacy scales have been developed over the years (Hillman, 1986; Morgan & Jinks, 1996; Tipton & Worthington, 1984) and extensive research into self-efficacy includes quantitative analysis of student self-efficacy beliefs and their potential for motivating academic performance (Jinks, Lorsbach, & Morey, 2001). General scales for measuring self-efficacy have been collated (Tipton & Worthington, 1984), but they have not adequately measured how self-efficacy alters behaviour in specific circumstances.

Research was conducted by Schwarzer (2001) who devised a ten-item version of the *General Self-Efficacy Scale* (GSES) and invested its usefulness across fourteen cultures in order to assess whether the construct of perceived self-efficacy was universal. McCoach and Siegle (2003) devised an instrument the School Attitude Assessment Survey – Revised (SAAS-R) that not only examined factors involving students' attitude toward school and teachers but included the dimension of self-perception to explore underachieving, academically able students.

The *Morgan-Jinks Self-Efficacy Scale* (MJSES) 'was designed to access information about student efficacy beliefs that might relate to school success' (Morgan & Jinks, 1996, p. 3). Using this instrument, it was found that there was a positive correlation between students' science grades and their sense of academic efficacy. It was interesting to note that the study emphasized the fact that 'it is not known if higher grades result in higher self-efficacy or if higher self-efficacy results in higher grades' (Morgan & Jinks, 1996, p. 7). The results using this instrument indicated that there was a positive correlation between students' science grades and their sense of academic efficacy. The MJSES (Jinks & Morgan, 1999) consisted of 34 items that included four self-report, self-grade achievement items. The overall reliability of the scale was 0.82. The sub-scale alphas were 0.78 for talent, 0.70 for context and 0.66 for effort.

Fisher, Aldridge, Fraser, and Wood (2001) adapted the MJSES to examine students' beliefs about their academic competence, and whether there was a link between students' perceptions of their competence and their perception of their learning environment. Their study also involved the use of the *Technology-Rich, Outcomes-Focussed Learning Environment Inventory* (TROFLEI), WIHIC and the compilation of a third instrument involving segments of TOSRA (Fraser, 1981), the *Computer Attitude Scale* (CAS) (Newhouse, 2001) and a scale referred to as academic efficacy from the MJSES (Jinks & Morgan, 1999). Their conclusions revealed that 'girls would prefer a different learning environment than boys and that the classroom environment is perceived more favourably than boys' (Fisher, Aldridge, Fraser, & Wood, 2001, p. 17).

Educational fields have pursued the concept of self-efficacy in an attempt to explain student performance in various subjects and significant research has also revealed the impact that teacher self-efficacy has on students. Riggs and Enochs (1990) developed an instrument that measured practicing teachers' levels of self-efficacy of teaching science, namely, the *Science Teaching Efficacy Belief Instrument* (STEBI-A). Subsequently, Schoon and Boone (1998) utilized the STEBI-B (Enochs & Riggs, 1990), a version used to examine science pre-service teachers' self-efficacy. Gibson and Dembo (1984) developed the *Teacher Efficacy Scale* (TES) and since then, Pontius (1998) and Kushner (1993) adjusted it to make it relevant to their research.

Students' science self-efficacy is of particular interest in this research. Kerns (1981) developed an instrument to measure chemistry self-efficacy. Tippins (1991) utilized the *Test of Science Self-Efficacy* (TSSE) and the *Student Self-Efficacy Scale* (SSES). She developed the TSSE and used it to assess 'science self-efficacy for technical skills, tasks problems and science-related coursework' (p. 1).

The *Science Self-Efficacy Questionnaire* (SSEQ) was developed by Smist in 1992, and was designed to assess students' science self-efficacy beliefs about competence in science. The pilot study was conducted on 826 high school students in New England and it was deemed to be reliable instrument. Satisfactory Cronbach alpha estimates were recorded for the four dimensions of self-efficacy being examined, namely; Biology, Physics, Chemistry and Laboratory self-efficacy. Baldwin, Ebert-May, and Burns (1999) instigated a study that used the *Biology Self-Efficacy Scale* (BSES). Their extensive study validated the use of the instrument that was constructed to measure students' self-reported confidence in understanding and using biology in their lives. The study illustrated an understanding of student behaviour and assisted with directing teaching strategies that could enhance students' desires to comprehend and further their study in biology.

4.4 SUMMARY

The focus of this chapter has highlighted the importance of student self-efficacy in the context of science education. It has displayed the fact that self-efficacy is learned and therefore levels can fluctuate. It has the ability to determine one's sense of academic potential in the science classroom and, therefore, science achievement. The role that teachers play in promoting high levels of self-efficacy is of paramount importance to students' development and may have a lifelong impact on their career path. It is hoped that teachers can adopt Bandura's social cognitive theory as a basis for designing a curriculum and presenting lessons that encourage student self-reflection and promote learning experiences that increase levels of self-efficacy. Self-efficacy has been shown to have an influence on motivation, attitude, learning, achievement and behaviour. Kurbanoglu (2003) stated that 'self-efficacy beliefs provide the foundation for human motivation, well-being and human accomplishment' (p. 638). Thus, the beliefs that students develop about their academic ability help to shape the development of their future successes.

This chapter has revealed how self-efficacy beliefs play an influential role in human agency. This research should provide avenues through which educators can examine students' self-beliefs about their capability and then apply their findings to valuable educational practice for all students. Throughout this research, it has become apparent that teachers must focus on improving students' self-efficacy in order to further their future involvement in and attitude towards science classes. Ultimately students' enjoyment of school and subsequent success is more like to follow if their level of self-efficacy is raised.

The next chapter provides an explanation of the intricacies of the methodology and the rationale behind the use of the various instruments used in this study.

CHAPTER 5

METHODOLOGY

5.1 INTRODUCTION

This chapter is designed to present the rationale behind choosing the instruments used in this study that assess the effect that teacher interpersonal behaviour has on student motivation, attitudes and self-efficacy in science. The two instruments utilized here are the Questionnaire on Teacher Interaction (QTI) and the Students' Motivation, Attitude and Self-Efficacy in Science (SMASES) questionnaire.

Chapter 2 was dedicated to presenting research that revealed the extent of classroom environment research and the development of the QTI. Section 2.2 addressed the vast amount of research conducted on classroom environment and, in Section 2.3 the research was directed towards examining the theoretical framework of teacher interpersonal behaviour. An extensive number of noteworthy studies covered in Section 2.4 justified the use of the QTI in this particular research. An abundant amount of research was conducted into reviewing studies that had successfully used the QTI to examine teacher interpersonal behaviour. Chapter 3 was dedicated to presenting a theoretical analysis of student motivation and attitudes towards learning science, and identified aspects of teacher interpersonal behaviour as determinants of students' behaviour. Chapter 4 highlighted the role that student self-efficacy plays in students' motivation, attitude and interest they display towards science.

Section 5.2 of this chapter initially presents an overview of the rationale for undertaking this particular research. The selection of the instruments chosen to be used in the study is clearly outlined in Section 5.3. A description of the development of the QTI and the SMASES is also discussed in Section 5.3 in some detail. The presentation of findings from a few studies that have used the *Students' Motivation Toward Science Learning* (SMTSL) and the *Attitude and Efficacy Questionnaire* (AEQ) will assist in supporting the production of a new instrument, the SMASES, for this research. The reliability and validity data of the QTI and the SMASES are presented in Section 5.4, and Section 5.5 presents an overview and summary of the validation statistics for the SMTSL, the Attitude towards Science scale and the AEQ which were used to construct the SMASES. The arduous task of collecting the data is explained in Section 5.6, and then the data analysis, quantitative and qualitative in nature, is presented in Section 5.7. The logistics behind using and combining qualitative and quantitative data justifies valid conclusions to be drawn from this research.

5.2 TOPIC SELECTION

Over the years of teaching science to thousands of students who displayed a vast array of abilities, it became obvious to the researcher that some students enjoyed their science lessons more than others. This was of some concern to think that some students who had ability but lacked the drive or interest, were deciding not to actively partake in science lessons or to pursue science after year 10. It was also of concern that students who were not achieving, could perhaps do so if they were exposed to a more affable classroom atmosphere. When conversing with students over the years, their belief was that teachers' ability to interact in the classroom with students had an immense impact on motivating their desire to learn science. It became evident throughout this research that students continually construct an assessment of their daily environment, and their interpretations have a direct effect on their personal learning capabilities.

Although extensive research has been conducted on teacher interpersonal behaviour, classroom environment, student motivation, students' attitudes towards science and students' self-efficacy, there has been no research that addresses the interrelatedness of all these concepts and the use of the QTI and the SMASES in one study. The literature reviews exposed theorists' views on factors affecting students' learning of science and reported significant findings in a quantitative and qualitative manner. In general, teacher interpersonal behaviour had a profound impact on students' self-efficacy and, therefore, their enjoyment of science. It was also noted that students who were motivated, achieved better results and adopted more positive attitudes towards their work.

The extensive literature reviews covered in Chapter 3 and Chapter 4 provided adequate evidence that there are a number of factors that have a marked influence on student learning. This particular research is unique, significant and useful by focusing on the influence that teacher interpersonal behaviour has on classroom environment, students' self-efficacy, attitudes and motivation towards science. This study followed Fraser and Tobin's (1991) notion of combining qualitative and quantitative data collection techniques that are elaborated on later in this chapter. The quantitative data were collected through the two questionnaires and the qualitative data through student interviews. The researcher is a science teacher in the school involved in this study, which made the understanding of students' feedback even more useful and useable for the science department within the college.

5.3 SELECTION OF RESEARCH INSTRUMENTS

5.3.1 Questionnaire on Teacher Interaction (QTI)

The QTI specifically measures teacher-student interpersonal behaviour and the 48-item economical version of the QTI developed in Australia (Wubbels, 1993) was implemented in this study. In the literature review in Chapter 2, this version was deemed to be valid and reliable, particularly when the class mean was used as the unit of analysis. A copy of the questionnaire that was used in this study is attached as Appendix A. A description and example items for each scale in the QTI are found in Table 5.1.

Table 5.1
Description and Example Items for Each Scale in the QTI

Scale	Description	Item
DC Leadership	Extent to which the teacher provides leadership to the class and holds student attention	This teacher explains things clearly.
CD Helping/ Friendly	Extent to which the teacher is friendly and helpful towards students	This teacher is friendly.
CS Understanding	Extent to which the teacher shows understanding and care to students	If we don't agree with this teacher, we can talk about it.
SC Student Responsibility/ Freedom	Extent to which the students are given opportunities to assume responsibilities for their own activities	We can influence this teacher.
SO Uncertain	Extent to which the teacher exhibits her/his uncertainty	This teacher seems uncertain.
OS Dissatisfied	Extent to which the teacher shows unhappiness/dissatisfaction with the students	This teacher thinks that we know nothing.
OD Admonishing	Extent to which the teacher shows anger/temper and is impatient in class	This teacher gets angry.
DO Strict	Extent to which the teacher is strict with demands of the students	We are afraid of this teacher.

Source: Wubbels (1993).

5.3.2 Students' Motivation, Attitude and Self-Efficacy in Science (SMASES)

The 32-item SMASES that was used in this study was formed by adapting relevant sections of the SMTSL (Tuan, Chin, & Shieh, 2005) to measure student motivation (14 items); the Attitudes Towards Science scale (10 items) based on TOSRA (Fraser, 1981) that measured students' enjoyment of science; and an academic self-efficacy scale (8 items) taken from an instrument called the Attitude and Efficacy Questionnaire (AEQ) (Fisher, Aldridge, Fraser, & Wood, 2001). All three instruments had high internal consistency and proved to be valid for use in this research. The combination of aspects of the SMTSL, TOSRA and the AEQ and an extensive review of their past uses, secured in the researcher's mind the need to devise the SMASES.

This compact instrument measured students' motivation, attitude and self-efficacy towards science and could be used in conjunction with the QTI to measure the influence that teacher interpersonal behaviour had on these three factors. Thus, the SMASES became an instrument that was adequately tapered to the researcher's topic. The scales were deemed to be salient for this particular study. A copy of the SMASES is attached as Appendix B.

Both questionnaires, the QTI and the SMASES were designed so that the students answered the questions directly on to the answer sheet and in close proximity to the question. Students responded to the QTI on a scale from 0 to 4 (Never to Always) and to the SMASES on a scale ranging from 5 (Strongly Agree) to 1 (Strongly Disagree). Sample items from the three questionnaires that assisted in the formation of the SMASES are located in Table 5.2.

Table 5.2
Description and Example Items for Each of the Scales of the SMASES

Scale	Description	Item
Science Learning Value (SMTSL)	The importance of science in learning	I think that learning science is important because I use it in my everyday life.
Performance Goal (SMTSL)	Reason for participating in science classes	I participate in science to get a good grade.
Achievement Goal (SMTSL)	Explaining student fulfillment in science classes	During a science course I feel most fulfilled when the teacher accepts my ideas.
Attitude Towards Science (TOSRA)	Students' attitudes towards science	I enjoy science lessons in this class.
Self-Efficacy (AEQ)	Students' self-belief in their ability	I find it easy to get good grades in this subject.

5.4 RESEARCH INSTRUMENTS: VALIDITY AND RELIABILITY

5.4.1 Questionnaire on Teacher Interaction (QTI)

The Questionnaire on Teacher Interaction (QTI) 48-item economical version (Appendix A) developed in Australia (Wubbels, 1993) was used in this study. The use of the QTI here stringently assesses students' perceptions of teacher interpersonal behaviour. The theoretical framework on which the QTI was developed and statistically analysed by Wubbels, Créton, and Hooymayers (1985) was examined in great depth in Chapter 2. Table 5.3 below summarizes the reliability (alpha coefficient) and validity for the QTI scales in American (USA), Australian (A) and Dutch (D) samples.

Table 5.3

Reliability (Cronbach Alpha Coefficient) for QTI-Scales on the Individual and the Class Level in American (USA), Australian (A) and Dutch (D) samples

	Student Level			Class Level		
	USA	A	D	USA	A	D
	(1606)	(792)	(1105)	(66)	(46)	(66)
DC Leadership	0.80	0.83	0.83	0.94	0.94	0.94
CD Helpful/Friendly	0.88	0.85	0.90	0.95	0.95	0.95
CS Understanding	0.88	0.82	0.90	0.94	0.94	0.96
SC Student Responsibility/ Freedom	0.76	0.68	0.74	0.86	0.80	0.85
SO Uncertain	0.79	0.78	0.79	0.96	0.92	0.92
OS Dissatisfied	0.83	0.78	0.86	0.90	0.93	0.92
OD Admonishing	0.84	0.80	0.81	0.92	0.92	0.90
DO Strict	0.80	0.72	0.78	0.95	0.90	0.89

Source: Wubbels & Levy (1993, p. 166).

It is essential that each scale within any instrument being used to investigate classrooms, records high levels of internal consistency. Scale internal consistency requires that each item within a scale measures the same aspect of behaviour every time the instrument is used. Cronbach’s (1951) alpha coefficient is calculated to determine if a scale has sufficient internal consistency to justify its inclusion in an instrument. Its reliability coefficient in a class is a measure of the degree of agreement between students about their perceptions of the teacher behaviour (Wubbels, Brekelmans, & Hooymayers, 1993). Nunnally (1967) postulated that scale internal consistency should be at least 0.60 for the instrument to be used in research. The values in Table 5.3 are based on the actual form of the QTI completed by students in the USA, Australia and The Netherlands. The Cronbach alpha coefficients were calculated using the student and the class mean as the unit of analysis. The calculated values are all well over the recommended 0.60 value and therefore, were deemed to be valid and reliable in all three studies in Table 5.3. It is also notable that the values were higher when using the class mean as the unit of analysis. Of particular interest is the Australian study, where the alpha coefficients were above 0.67 at the student level and above 0.80 at the class level. This justifies the use of the QTI in giving accurate feedback to teachers about their interpersonal behaviour.

Another feature of the QTI is that it is a circumplex model. In a circumplex model, the correlations should become lower as one moves away from a scale around the model. Thus, the highest negative correlations should occur with the scale opposite in the model (Wubbels, Brekelmans, & Hooymayers, 1991). Furthermore, the scales that are adjacent to each other in the eight sectors of the QTI have significant correlations. Thus, correlations between scales that occur next to each other on the circular representation of the Leary model (see Figure. 2.1) should have the largest correlation. These occurrences are clearly illustrated in Table 5.4 that were recorded by a Dutch study. For example, the correlation between DC and CD was 0.61 for the student sample. In comparison, the scales opposite each other, for example, DC and SO had a large negative correlation of -0.72 for the student sample. These results confirmed the circumplex nature of the QTI. Both the reliability figures and the confirmation of the circumplex nature of the QTI suggested that it could be used in this study with some confidence.

Table 5.4
QTI Scale Correlations in a Dutch study

	CD	CS	SC	SO	OS	OD	DO
DC	.61	.50	-.12	-. 72	-.48	-.33	.02
CD		.86	.38	-.34	-.68	-.60	-.42
CS			.44	-.23	-.69	-.63	-.49
SC				.34	-.24	-.33	-.48
SO					.44	.29	-.03
OS						.76	.53
OD							.58

n = 2,407 students

Source: Wubbels, Créton, & Hooymayers (1985).

A third important quality of classroom environment instruments like the QTI is its ability to differentiate between the perceptions of students in different classrooms. That is, students in the same class should perceive it quite similarly, while mean within-class perceptions should vary from class to class. Thus, differences in students' perceptions are more a result of class differences than student differences (Wubbels, Créton, Levy, & Hooymayers, 1993). Rickards and Fisher (1999) examined this concept for each scale of the QTI using a one-way analysis of variance (ANOVA) that determines an instrument's capacity to differentiate between classes. Their research (Table 5.5) highlighted the fact that each QTI scale differentiated significantly (p<0.001) between classes and that the eta^2 statistic, representing the proportion of variance of scores accounted for by class membership, ranged from 0.17 to 0.31 for different scales.

Table 5.5
Internal Consistency (Cronbach Alpha Coefficient) and Ability to Differentiate Between Classrooms for the QTI

Scale	Unit of analysis	Alpha reliability	ANOVA results (eta^2)
Leadership	Individual	.81	.29*
	Class Mean	.88	
Helping/Friendly	Individual	.86	.31*
	Class Mean	.92	
Understanding	Individual	.83	.26*
	Class Mean	.88	
Student Responsibility/	Individual	.65	.26*
Freedom	Class Mean	.79	
Uncertain	Individual	.69	.21*
	Class Mean	.78	
Dissatisfied	Individual	.78	.17*
	Class Mean	.84	
Admonishing	Individual	.75	.25*
	Class Mean	.79	
Strict	Individual	.62	.24*
	Class Mean	.72	

*p<0.001, n = 3,215

Source: Rickards & Fisher (1999).

Rickards and Fisher (1999) also reported on the reliability of the QTI scales for their large sample. The alpha reliability figures for different QTI scales ranged from 0.62 to 0.86 when the individual student was used as the unit of analysis, and from 0.72 to 0.92 when the class mean was used as the unit of analysis. These figures present further support of the internal consistency of the QTI and, therefore, justify its use in classroom research.

5.4.2 Students' Motivation, Attitude and Self-Efficacy in Science (SMASES)

The Students' Motivation, Attitude and Self-Efficacy in Science (SMASES) questionnaire was devised specifically for this study and is attached as Appendix B. The 32-item questionnaire was composed by amalgamating portions of three existing questionnaires. Students responded to each item on a five-point Likert-type scale. Firstly, the construction of the SMASES used Section C (Science Learning Value), Section D (Performance Goal) and Section E (Achievement Goal) that formed the Motivation sections of the Students' Motivation Toward Science Learning (SMTSL) (Tuan, Chin, & Shieh, 2005). These three sections became Sections A, B and C respectively of the SMASES. Section D of the SMASES was comprised of a ten-item Attitude Towards Science scale based on the TOSRA (Fraser, 1981). Section E of the SMASES is an eight-item scale that measured student self-efficacy and was developed from an Academic Self-Efficacy questionnaire used by Fisher, Aldridge, Fraser, and Wood (2001).

5.4.2.1 Students' Motivation Toward Science Learning (SMTSL)

Tuan, Chin, and Shieh (2005) developed and validated the SMTSL, and the framework of the SMTSL was used to construct the motivation aspect of the SMASES. The intesting of the SMTSL involved 1,539 junior high school students in Taiwan who completed the 35-item questionnaire. Table 5.6 illustrates exemplary items of the SMTSL that were used to construct sections A, B and C of the SMASES.

Table 5.6
Categories and Exemplary Items in the SMTSL

Category	Description	Example items
Science Learning Value	Students are motivated to learn science because they perceive there is value in learning science.	I think that learning science is important because I use it in my daily life.
Performance Goal	The student's goal in science learning is to perform better than other students.	I participate in science classes so that other students think I'm smart.
Achievement Goal	Students feel fulfilled as they increase their ability during science learning.	During a science course I feel most fulfilled when I attain a good score in a test.

Source: Tuan, Chin, & Shieh (2005).

The following statistical analysis in Table 5.7 confirmed the validity and reliability of the SMTSL. The construction of the SMTSL involved the modification of *Patterns of Adaptive Learning* (PALS) (Midgley, et al., 2000) items, and included extra items that were based on consultations with educational psychologists, science educators and experienced science teachers to assess content validity. Initially the questionnaire was quantitatively tested on four classes and the qualitative research involved 24 students. This pilot study involved 315 students and the Cronbach alpha reliability proved to be above 0.70 for each of the six scales of the questionnaire and 0.89 for the entire questionnaire.

Table 5.7
Cronbach Alpha Reliability Values for Each Scale of the SMTSL

Scale	Cronbach Alpha Reliability
Self-Efficacy	0.82
Active Learning Strategies	0.87
Science Learning Value	0.70
Performance Goal	0.81
Achievement Goal	0.80
Learning Environment Stimulation	0.75

Source: Tuan, Chin, & Shieh (2005)

There was also a significant correlation ($p<0.0001$) of the SMTSL with students' science attitudes. Thus the SMTSL had a high internal consistency and good validity. It also revealed a high correlation between science attitudes ($r=0.41$) and academic achievement ($r=0.38$). The important feature of this questionnaire is that it distinguished between students' various levels of motivation ($p<0.0001$).

5.4.2.2 Test of Science Related Attitudes (TOSRA)

The Test of Science Related Attitudes (TOSRA) (Fraser, 1981) was based on Klopfer's (1971) classification of attitudinal and interest objectives specific to science. Fraser (1981) used the Klopfer classification to generate seven scales that measure students' science attitudes. Klopfer developed six categories of attitudinal aims: H1: Manifestation of favourable attitudes towards science and scientists; H2: Acceptance of scientific inquiry as a way of thought; H3: Adoption of 'scientific attitudes'; H4: Enjoyment of science learning experiences; H5: Development of interest in science and science-related activities; and H6: Development of interest in pursuing a career in science (Meyer, 1995, p. 6). The development of the seven TOSRA scales closely reflects Klopfer's classification. Fraser (1981) developed the following scales: Social Implications of Science (S) and Normality of Scientists (N) to align with Klopfer's H1. The next five scales in TOSRA correspond to Klopfer's H2 to H6 respectively: Attitude to Scientific Inquiry (I); Adoption of Scientific Attitudes (A); Enjoyment of Science Lessons (E); Leisure Interest in Science (L); and Career Interest in Science (C).

In the testing of TOSRA, 1,337 students completed the survey, and Cronbach reliabilities across grade levels for Enjoyment of Science Lessons ranged from 0.92 to 0.93. The mean correlation with other scales ranged from 0.13 to 0.40. Thus, the TOSRA proved to be a most useful, reliable and valid instrument for use in Australia. Further research suggested cross-cultural validity of the TOSRA after its successful use in the USA (Fraser, 1981).

A ten-item 'Attitude Towards Science' scale was used as Section D of the SMASES and was used in this research as the second outcome measure. It was adopted from the 'Enjoyment of Science Lessons' scale of the TOSRA (Fraser, 1981). Sample items include, 'I look forward to science lessons,' and 'Science lessons are fun'. The items were answered on a five-point Likert-type scale ranging from five (strongly agree) to one (strongly disagree).

It was used in a similar manner by Rickards and Fisher (1999) who conducted a study with 3,215 science students to determine associations between students' perceptions of their teachers' interpersonal behaviour, the cultural background of students and their attitudinal and cognitive achievement. They found associations between the QTI scales and students' attitudinal outcomes. Generally, students' attitude scores were higher in classrooms in which students perceived higher levels of leadership, helping, friendly, and understanding behaviours of their teachers, ranging from 0.44 to 0.51 ($p<0.01$). Negative associations for attitude were recorded for the Uncertain, Dissatisfied, Admonishing and Strict scales.

This study by Rickards and Fisher (1999), illustrated the usefulness of the QTI and attitude questionnaires in identifying associations between students' perceptions of teacher interpersonal behaviour and the effect on student attitudes. Another significant study that highlighted associations between QTI scales and students' attitude was conducted by Henderson, Fisher, and Fraser (2000) and in general, where students perceived greater leadership and helping/friendly behaviours in their teachers, there were more favourable attitudes towards the class. In relation to the simple correlation (r), statistically significant associations were identified between students' attitudinal outcomes and all the QTI scales except Student Responsibility/Freedom. Thus teachers are encouraged to reflect these types of behaviours in order to promote favourable student attitudes in the classroom.

5.4.2.3 Self-Efficacy Scale

Another outcome measure in the SMASES is included as Section E. A simple 8-item questionnaire measured student academic self-efficacy. Self-efficacy beliefs are viewed in this research as an important determinant of student learning. A previous use of this scale was used by Fisher, Aldridge, Fraser, and Wood (2001) and their findings justified its use here. The academic self-efficacy scale used in their study was adapted from one developed by Jinks and Morgan (1999) the Morgan and Jinks Self-Efficacy Scale (MJSES). Thus, they constructed the Attitude and Efficacy Questionnaire (AEQ) which was composed of an attitudes measure devised from

TOSRA, an attitude towards computer usage scale (Newhouse, 2001) and the academic self-efficacy scale (Morgan & Jinks, 1999).

One aspect of the AEQ was used to examine how the learning environment created by teachers, influenced students' attitudes and academic self-efficacy. These researchers also used the 69-item, nine scale Technology-Rich, Outcomes Focussed Learning Environment Inventory (TROFLEI) to examine the impact that technology had on students' attitudes towards learning and computer usage. Data were collected from 386 students in 33 classes and results related to the TROFLEI and the AEQ. The internal consistency reliability for academic self-efficacy was 0.82 using the individual as the unit of analysis and 0.84 when the class mean was used as the unit of analysis. The mean correlation of the others with the Academic Efficacy scale was 0.16 using the individual as the unit of analysis and 0.14 using the class mean as the unit of analysis, indicating that it was measuring something distinct.

A simple correlation and multiple regression analyses for associations between student attitude, self-efficacy and the nine dimensions of the TROFLEI were also conclusive. These results indicated positive and significant relationships (p<0.01) between the nine scales of the TROFLEI and Academic Self-Efficacy, with values ranging from 0.20 to 0.39. The multiple correlation (R) of 0.55 between students' perceptions of the learning environment and self-efficacy was statistically significant (p<0.01), suggesting that the learning environment is positively related to students' academic efficacy. Overall, previous studies have illustrated satisfactory levels of internal consistency and validity using both the individual and the class mean as the unit of analysis.

5.5 SAMPLE SELECTION AND ADMINISTRATION PROCEDURES

This study investigated teacher interpersonal behaviour and its effect on student motivation, self-efficacy and attitude towards science. The research was conducted in a private girls' college in Brisbane, Australia, where the researcher was employed. The school's population was approximately 520 students who were of varying socio-economic background. The study entailed collecting data from 313 students from the 12 classes of junior (year levels 8, 9 and 10) science, that is, the classes of five female science teachers including the researcher's classes. Students who answered the questionnaires were studying various topics in science, including anatomy and physiology, earth science, chemistry and physics units. Brekelmans (1989) suggested that a minimum of ten students and two classes be sampled for each teacher to calculate a reliable measure of overall style. This advice was adhered to for this study, with the exception of the analysis on one teacher who only taught one junior science class.

To initiate the process of the collection of quantitative and qualitative data within the school, permission was sought from the Principal via a formal letter (Appendix C). The Principal was also given a copy of the QTI and the SMASES for perusal. A paper by Wubbels (1993) also accompanied the request for the college to partake in the study. Once permission was granted for the study to occur, the researcher personally addressed the science department within the college at a departmental meeting, to outline the purpose of the study and the procedures involved in the collection of the quantitative data. The researcher was aware of time constraints in the school's timetable and assured the staff that the two questionnaires would take no longer than 40 minutes to complete. The researcher also provided explicitly typed instructions to aid the teacher's easy administration of the test. The confidentiality of students' responses was stressed to the science staff and the Head of Department was assured of feedback of the results.

Once the science staff agreed to administer the questionnaires, the researcher sent a 'Letter to Parents' (Appendix D) that emphasised the nature of the research, sought parental approval for their child's participation and assured the confidentiality of the individual's responses. The signed permission slip from parents was returned by the students to their science teacher and all parents who received the letter, acknowledged and approved of their child's involvement in the study.

It was anticipated that the two questionnaires would be completed soon after the Principal granted permission for the data collection to take place. However, due to the fact that the College's junior science program adopted a unitization approach to students' selection of particular science units, all students, early in term three had a new science teacher. Thus, the collection of data was delayed for eight weeks. The researcher believed that the time delay provided ample opportunity for students to familiarize themselves with their then current teacher's interpersonal behaviour and classroom routine more thoroughly.

Ten percent of the students who answered the questionnaires from each of the 12 classes, therefore 31 students, were randomly selected to partake in the collection of the qualitative data. The students were interviewed in small groups from each class in order to obtain their opinions on specifics about their teacher's interpersonal behaviour. They were interviewed during their lunch hour so as not to intrude into the students' time outside school hours or class time.

5.6 DATA COLLECTION

5.6.1 Combining Quantitative and Qualitative Data

Prominent researchers including Fraser and Tobin (1991) promote the combined use of collecting quantitative and qualitative data when investigating educational environments. Fraser (1991) deduced that qualitative research complements quantitative information in that it provides additional information on student perceptions of the classroom psychosocial environment. Fraser and Tobin (1991) highlighted the fact that teachers placed great importance on ensuring that meaningful and personalized learning occurred in the classroom. They attested that 'a confluence of quantitative and qualitative methods is a desirable future direction for research on learning environments' (Fraser & Tobin, 1991, p. 290). It was with these views in mind that the researcher collected both forms of data for this research. Presented in the following section is an analysis of how the quantitative and qualitative analysis took place and how the use of the two instruments assisted in the understanding and explanation of numerous contributing factors that can affect students' learning of science.

5.6.2 Quantitative Data

The science classes in each year level in the College were timetabled at the same time which made the administration of the questionnaires most convenient. Each science teacher was given a copy of their class roll and the appropriate number of questionnaires which aided the quick administration of the task. Absentees were recorded by the teacher and the researcher followed up these students, who obliged in completing the questionnaires during one lunch hour during that same week. The QTI (Appendix A) and the SMASES (Appendix B) were both accompanied by a cover sheet that provided an example question, response method and identification of the student and their teacher. The QTI was photocopied onto pink paper and the SMASES onto blue paper to enable students to easily confirm that they were answering two different questionnaires. The final number of students who completed the QTI and the SMASES was 313 representing 12 classes of year 8, 9 and 10 students. The QTI collected students' perceptual information on teacher-student interpersonal behaviour and the SMASES gathered students' responses to questions designed to analyse students' motivation, attitude and self-efficacy in science.

On the collection of the quantitative data, rolls were cross-checked to ensure that all students present completed the one-page QTI and the two-page SMASES. The questionnaires were bundled and coded in relation to the teacher number. The questionnaires were completed by all 12 classes within two days. They were delivered to the researcher's desk and placed in a clearly labeled box immediately after the administration of the questionnaires.

5.6.3 Qualitative Data

A total of 31 students cooperated with answering interview questions in relation to their teacher's interpersonal behaviour; their classroom environment; their general attitude towards science and their perception of their teacher's influence on their self-efficacy in the science classroom. The researcher assured the students that their views would not be discussed outside the interview room, in particular, with their teacher. Their comments and responses were recorded on an audio cassette. The qualitative data were used purely to aid the researcher's interpretation of the quantitative data. The qualitative data were collected from the students during numerous lunch hours so as not to interrupt the daily classroom routine. In the initial 'Letter to Parents,' parents were notified about the intention of interviewing students after the completion of the questionnaires. Therefore, the researcher deemed it to be unnecessary to write another letter to parents seeking approval for their child to be involved in the interviews that were designed to collect the qualitative data.

The students who were interviewed answered pre-set questions (Appendix E) and the interviewer probed for some answers to be elaborated upon to further understand the full meaning of the students' responses. Questions that were posed, searched for students' feedback on how they thought teacher interpersonal behaviour influenced classroom environment, their motivation, self-efficacy and attitude in science classes.

5.7 DATA ANALYSIS

5.7.1 Quantitative Data

Once the student responses were collected, they were examined by the researcher to ensure that all questions on both questionnaires were answered by all students. In a few instances students had inadvertently omitted a section of the questionnaire and, therefore, that section of the questionnaire was not analysed for those students. After the data had been scrutinized, the student responses were entered class by class for each teacher into a Microsoft XP Word document. The data were collated for analysis by assigning each teacher a code number, followed by a student reference number, then the responses to the QTI (using numbers 0 to 4) and the SMASES (using numbers 5 to 1).
The data that were entered into the Word document were then transferred to SPSS Version 6.1 and the class means and standard deviations were calculated for each of the eight scales of the QTI and the Science Learning Value, Performance Goal, Achievement Goal, the Attitude Towards Science and the Self-Efficacy scale of the SMASES. Scale reliability, differentiation and discriminant validity statistics were carried out using the individual and class means as the unit of analysis for all scales of the QTI and the SMASES. Simple correlation and multiple correlation analyses were also calculated for each scale of the QTI and the SMASES.

5.7.2 Qualitative Data

The qualitative data that were collected from the students were recorded on an audio cassette and notes from the responses were transcribed for the researcher. Responses that reflected common trends and opinions that were considered by the researcher to be worthy of interpretative analysis were recorded for elaboration to be presented in Chapter 7. Coupled with the quantitative results that are presented in Chapter 6, the qualitative data provided support for the quantitative results and further explanation of the responses.

5.8 SUMMARY

This chapter has presented an overview of the following: the selection of the quantitative instruments, the QTI and the SMASES; previous research that justified their validity and suitability for use in this study; how the quantitative and qualitative data were collected and the general procedures involved in the analysis of the data. The intricacies of the data collection and data analysis were discussed in some detail. The administration of the questionnaires was conducted at a convenient time by each science teacher. The teachers were given clear administrative procedures to follow and the questionnaires were conducted in a non-threatening manner in the presence of the student's science teacher. Having the actual teacher present in the room as the administrator of the QTI and the SMASES enhanced the relevance of the questions as the students were able to visualize the actual teacher and reflect on their teacher's manner they were referring to on the questionnaires.

Unfortunately feedback from other schools that were approached to be involved in this study led the researcher to believe that the study may have been deemed potentially invasive. That is, teachers may have felt threatened because their interpersonal behaviour was to be analysed by students. Thus, only one of the schools approached was responsive, positive and encouraging in relation to this particular piece of research.

The next chapter provides statistical analysis that confirmed the reliability of the QTI and the SMASES.

CHAPTER 6

VALIDATION OF QTI, SMASES AND ATTITUDE AND SELF-EFFICACY SCALES

6.1 INTRODUCTION

This chapter discloses the analysis and draws valid conclusions about the quantitative data collected in this study that assist in validating the Questionnaire on Teacher Interaction (QTI) and the Students' Motivation, Attitude and Self-Efficacy in Science questionnaire (SMASES). This research embraced the perceptions that students in years 8, 9 and 10 held about their teacher in their science classroom. The first section presents the statistical data that reflect students' perceptions about teacher interpersonal behaviour in their science classroom. This chapter then provides validation data for the SMASES for use in secondary schools' science classrooms.

6.2 VALIDATION OF THE QTI

This study provided further evidence that the QTI and the SMASES are valid and reliable instruments for assessing teacher interpersonal behaviour in secondary schools' science classrooms. In keeping with past research with the QTI, the usual statistical tests were applied to examine the validity of the QTI and the SMASES in this context.

6.2.1 Students' Perceptions of Teacher Interpersonal Behaviour

A variety of tests were executed in order to establish the validity and reliability of the QTI. Namely, Cronbach's alpha reliability ratio was used to determine scale internal consistency and a one-way ANOVA was used to establish whether each scale of the questionnaire was able to differentiate significantly between the perceptions of students in different classes. Also, the circumplex nature of the QTI was investigated.

6.2.1.1 Internal Consistency

The extensive use of the QTI was outlined in Chapter 3 and the Australian version of the QTI was used in this study to determine students' perceptions of teacher-student interpersonal behaviour. It has now been established that the QTI is a valid and reliable instrument and has been effectively used in research to develop typologies for students' perceptions of teacher interpersonal behaviour. The questions comprised in the eight scales of the QTI were answered by the students on a five-point Likert scale (0 to 4). It is apparent from Table 6.1 that the alpha coefficient calculated in this study for different QTI scales ranged from 0.64 for the Admonishing scale to 0.87 for the Helping/Friendly scale, which are above the recommended 0.60 (Nunnally, 1967), thus illustrating solid reliability.

Table 6.1
Internal Consistency (Alpha Reliability) and Ability to Differentiate between Classrooms for the QTI Scales

Scale	Alpha Reliability	ANOVA results (*eta*²)
DC Leadership	0.84	0.16***
CD Helping Friendly	0.87	0.26***
CS Understanding	0.82	0.19***
SC Student Responsibility/ Freedom	0.65	0.10***
SO Uncertain	0.75	0.07***
OS Dissatisfied	0.79	0.13***
OD Admonishing	0.64	0.21***
DO Strict	0.74	0.30***

*** $p<0.001$ n = 313

Previous notable studies using the QTI and examining its internal consistency have been conducted in America (Wubbels & Levy, 1991) and in The Netherlands (Wubbels, Créton, & Hooymayers, 1985). The American version of the QTI comprised 64-items compared to the Dutch version that contained 77-items. The researcher in this study used the Australian version that included 48-items.

Table 6.2 allows for comparisons of internal consistency results between significant studies that have used the QTI. Such cognate studies have proven the versatility of the QTI in other countries as well as in Australia and therefore, validates the QTI. A previous Australian study (Rickards & Fisher, 1999) recorded alpha reliabilities at the student level ranging from 0.62 Strict to 0.86 for Helpful/Friendly. It is noteworthy to recognize the similarity in relation to the alpha coefficients obtained in this Australian study. For this particular study, the alpha reliability figures ranged from 0.64 to 0.88 for Admonishing and Helping/Friendly scales respectively. Thus, this research provides validation information that supports the internal consistency with the individual as the unit of analysis.

A comparative analysis of the reliability coefficients highlights the questionnaire's usefulness in being able to measure the same aspect of behaviour for any teacher. Table 6.2 illustrates that all reliability values are above 0.60 indicating that all scales have reliable internal consistency and enable acceptable and valid conclusions to be drawn. Thus, 'students' answers within a class can be considered to be repeated measures of the same variable, teacher behaviour. Then Cronbach's alpha reliability coefficient in a class (with students treated as the items) is a measure of the degree of agreement between students about their perceptions of the teacher behaviour' (Wubbels, Brekelmans, & Hooymayers, 1993, p. 144).

Table 6.2

Internal Consistency (Alpha Reliability) for QTI Scales at the Student Level in Three Countries

Scale	(Australia) n=313	(Australia) n=3,215	(USA) n=1606	(Netherlands) n=1105
Leadership	0.84	0.81	0.80	0.83
Helping/Friendly	0.88	0.86	0.88	0.90
Understanding	0.82	0.83	0.88	0.90
Student Responsibility/Freedom	0.65	0.65	0.76	0.74
Uncertain	0.75	0.69	0.79	0.79
Dissatisfied	0.79	0.78	0.83	0.86
Admonishing	0.64	0.75	0.84	0.81
Strict	0.74	0.62	0.80	0.78

Significant studies in relation to interpersonal behaviour in science classrooms have relied upon the QTI to illustrate acceptable internal consistency (Fisher, Henderson, & Fraser, 1995; Fisher, Rickards, Goh, & Wong, 1997; Rickards & Fisher, 1999; Rickards, den Brok, & Fisher, 2003). It is encouraging to note, that results by these researchers are generally similar to those recorded in other prominent studies and in this particular research. However, it is acknowledged that cultural and social contexts may affect these comparisons.

6.2.1.2 Ability to Distinguish Between Classrooms

A plethora of pertinent studies have strongly suggested that a one-way ANOVA *eta*^{2} statistical analysis is invaluable in forming opinions on whether an instrument can adequately differentiate between classrooms. Copious amounts of research using a one-way ANOVA have been carried out and successfully explored students' perceptions of teacher-student interpersonal behaviour. It has been concluded that the QTI has the ability to be able to differentiate between the perceptions of students in different classrooms. Students in the same classroom should perceive their environment similarly; however, class perceptions should alter from class to class. This concept was investigated for the classes in this study by using a one-way ANOVA, with class membership as the main effect. It was found that that each QTI scale differentiated significantly between classes ($\rho<0.001$) and the *eta*^{2} statistic (Table 6.1), representing the proportion of variance in scale scores (class membership) ranged from 0.07 for the Uncertain scale to 0.30 for the Strict scale, indicating adequate scale differentiation. This analysis indicates that each scale of the QTI is capable of differentiating significantly between classes and it is a valid instrument to measure students' perceptions of teacher-student interpersonal behaviour.

Values obtained by Fisher and Rickards (2000) for the *eta*^{2} statistic ranged from 0.22 to 0.35 ($p<0.001$). Scott and Fisher (2004) also observed the fact that the QTI scales significantly differentiated between classes ($p<0.001$) having recorded *eta*^{2} scores that ranged from 0.14 to 0.24. Waldrip and Fisher (2000b) investigated teacher-student interactions and the effect they have on students' attitudes at a primary school level using the QTI. Their comments evoked a powerful message for all science teachers, 'it is during the primary school experience that many students begin to form ideas and attitudes towards science as they interact with their students' (p. 467). Their study validated the QTI and displayed the fact that the QTI was capable of differentiating significantly between classes, recording *eta*² scores that ranged from 0.20 to 0.35. Fisher, Rickards, Goh, and Wong (1997) found that the *eta*² statistic range from 0.15 to 0.40 in Australia and 0.13 to 0.47 in Singapore.

6.2.1.3 Inter Scale Correlations

A test that examines the validity of the QTI determines whether there is correlation between scales. Table 6.3 provides the correlations between the scales found in this study. Generally, the scale correlations test the circumplex nature of the QTI, that is, the scales should correlate closely with adjacent scales and negatively with those opposite. That is, as one moves around the model, the correlations should become lower. These figures and the scale correlations in Table 6.3 and Figures 6.1 and 6.2 confirm the assumptions of the circumplex nature of the Model of Interpersonal Behaviour (Wubbels, Créton, Levy, & Hooymayers, 1993). This feature is illustrated in Figure 6.1 for the Helping/Friendly scale and Figure 6.2 for the Uncertain scale.

Table 6.3
QTI Inter Scale Correlations

	CD	CS	SC	SO	OS	OD	DO
DC	0.73	0.74	0.11	-0.53	-0.57	-0.41	-0.39
CD		0.81	0.34	-0.46	-0.60	-0.47	-0.56
CS			0.34	-0.47	-0.63	-0.57	-0.58
SC				0.11	-0.10	-0.13	-0.32
SO					0.57	0.42	0.34
OS						0.55	0.60
OD							0.50

In both cases it is evident that opposing scales are negatively correlated and adjacent scales are closely related.

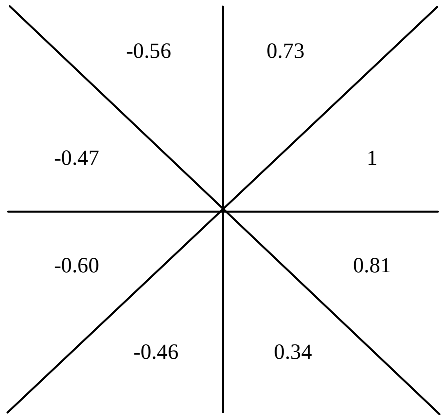

Figure 6.1. Example of interscale correlations for the CD scale.

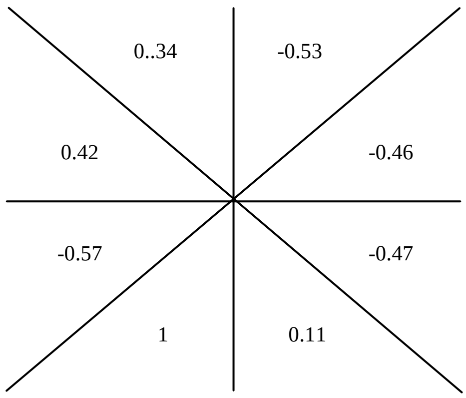

Figure 6.2. Example of interscale correlations for the SO scale.

These results confirm the circumplex nature of the QTI, further justifying that the QTI can be used with confidence to examine teacher interpersonal behaviour and classroom environment.

6.3 VALIDATION OF SMASES

Another main objective of this study was to determine the validity of the motivation, attitude and self-efficacy scales. A range of statistical analyses were performed to investigate the validity of the instrument devised for this study, the SMASES.

6.3.1 Students' Perceptions of Their Level of Motivation, Attitude and Self-Efficacy in Science using the SMASES

It was the intent of this research to use the SMASES to measure students' levels of motivation, their attitude to and their self-efficacy in science. These measures were then able to be correlated against the scales of the QTI to identify the type of teacher that students' perceived enhanced their ability to learn.

6.3.1.1 Internal Consistency

The alpha reliabilities for the five scales of the SMASES are recorded in Table 6.4 and they range from 0.75 for Performance Goal to 0.94 for Attitude in relation to science. These values provide evidence to suggest that the SMASES is a reliable instrument designed to evaluate students' perceptions of their motivation, attitude and self-efficacy in science.

Table 6.4
Internal Consistency (Alpha Reliability) for the SMASES

Scale	Alpha Reliability
Student Learning	0.80
Performance Goal	0.75
Achievement Goal	0.81
Attitude	0.94
Self-Efficacy	0.85

n = 313

Having provided evidence of the reliability and validity for the QTI and SMASES, associations between the QTI scales and the SMASES scales were investigated.

6.4 ASSOCIATIONS BETWEEN QTI SCALES AND SMASES SCALES

This study investigated associations between the outcomes of student attitudes, motivation and self-efficacy and the eight scales of the QTI. Simple (*r*) and multiple (*R*) correlation analyses were used on the data that were collected from 313 students. In this research, the simple correlations (*r*) describe the bivariate associations between the outcomes and each scale of the QTI. The multiple correlation (*R*) describes the multivariate association between an outcome and a specific scale, when all other scales are controlled.

6.4.1 Outcomes Association with Teacher-Student Interpersonal Behaviour

6.4.1.1 Attitude and Teacher-Student Interpersonal Behaviour

The multiple correlation (*R*) between students' perceptions of the eight QTI scales and the Attitude scale is 0.60 at the student level of analysis. With attitude to science as the dependent variable, Table 6.5 shows that simple correlations (*r*) were statistically significant for seven of the eight scales of the QTI. The R^2 value of 0.36 indicates that 36% of the variance in students' attitude could be attributed to their perceptions of their teachers' classroom behaviour. Thus, teacher interpersonal behaviour is positively related to students' attitudes towards their subject. Similarly, Wubbels and Levy (1993) revealed that students' perception of teacher interpersonal behaviour accounted for 55% of the variability in attitudinal outcomes. Four scales were associated positively with attitude, that is, when teachers displayed leadership, helping/friendly, understanding behaviours and when students were given responsibility and freedom in the classroom, the students had better attitudes towards science. When teachers exhibited uncertain, admonishing, dissatisfied and strict behaviours, students' attitude was less positive. When using the standardised regression coefficient (β), a measurement that determines the association when the effect of the other scales is controlled, leadership and helping friendly behaviour retained their significance. Thus, students' positive attitude towards science was more evident when teachers displayed leadership and helping/friendly behaviours.

Table 6.5

Significant Associations between QTI Scales and Attitude towards Science Lessons in terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scales	r	β
Leadership	0.55**	0.35***
Helping/Friendly	0.54**	0.32***
Understanding	0.46**	-0.16
Student Responsibility/Freedom	0.11	-0.02
Uncertain	-0.35**	-0.02
Dissatisfied	-0.41**	-0.02
Admonishing	-0.35**	-0.10
Strict	-0.36**	-0.08
Multiple R	R = 0.60***	R^2 = 0.36

**p<0.01 ***p<0.001 n = 313

6.4.1.2 Self-Efficacy and Teacher Interpersonal Behaviour

The simple correlation data in Table 6.6 reveals that all eight scales of the QTI significantly influence student self-efficacy. Significant associations for the scales of Leadership, Helping/Friendly, Understanding and Student Responsibility and Freedom are positive and the scales of Uncertain, Dissatisfied, Admonishing and Strict are negative. These associations infer that high levels of student self-efficacy are enhanced by teachers who display leadership, helpful/friendly and understanding behaviours and allow a certain amount of student responsibility and freedom in their classrooms.

Table 6.6

Significant Associations between QTI Scales and Self-Efficacy in Science in terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scales	r	β
Leadership	0.33**	0.21*
Helping/Friendly	0.35**	0.16
Understanding	0.33**	-0.01
Student Responsibility/Freedom	0.18**	0.08
Uncertain	-0.13*	0.09
Dissatisfied	-0.22**	0.03
Admonishing	-0.28**	-0.17*
Strict	-0.21**	0.02
Multiple R	R = 0.40***	R^2 = 0.16

* p<0.05 **p< 0.01 n = 313

The multiple correlation (R) between students' perceptions of the eight QTI scales and the Self-Efficacy scale is 0.40 (p<0.001) at the student level of analysis (Table

6.6). This result suggests that teacher interpersonal behaviour is positively related to students' self-efficacy towards their subject. The R^2 statistic indicates that 16% of the variance in students' self-efficacy in science is explained by students' perceptions of teacher-student interpersonal behaviour. When interrelationships of QTI scales are controlled, only Leadership and Admonishing remain significant. As such, teachers who show high levels of leadership influence student self-efficacy in a positive manner and teachers who display admonishing behaviours are influential in lowering student self-efficacy.

It can also be deduced that teacher behaviour that errs on being uncertain, dissatisfied, admonishing or strict, decreases the students' capability of developing positive levels of self-efficacy.

6.4.1.3 Achievement Goals and Teacher-Student Interpersonal Behaviour

The simple correlation data (r) in Table 6.7 indicates that all associations between students' achievement goals and the QTI scales are statistically significant, except for the Strict scale. That is, teachers' strict behaviour does not have a significant statistical influence on determining students' achievement goals. Again the Leadership, Helping/Friendly, Understanding and Student Responsibility and Freedom scales have a positive influence on students being motivated to achieve in science. Whereas, uncertain, dissatisfied and admonishing behaviours have a negative impact on students' desire to achieve. When the interrelationships of the QTI scales are controlled and the standard regression weights (β) are examined, two out of the eight scales produce significant relationships. The Leadership scale remains a significant ($p<0.05$) influence on student achievement goals in science and the Strict scale becomes significant ($p<0.05$). It is noted that the effect of the Srict scale is apparently masked by associations with the other scales in the simple correlation. The multiple correlation (R) statistic of 0.39 ($p<0.001$) suggests that there is a strong association between students' perceptions of teacher-student interpersonal behaviour, as measured by the QTI and students' achievement goals, thus, motivation in science. The R^2 statistic indicates that 15% of the variance in students' achievement goals is explained by students' perceptions of teacher-student interpersonal behaviour.

Table 6.7

Significant Associations between QTI Scales and Achievement Goals in Science in terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scales	r	β
Leadership	0.35**	0.20*
Helping/Friendly	0.33**	0.14
Understanding	0.32**	0.13
Student Responsibility/Freedom	0.13*	0.07
Uncertain	-0.18**	-0.01
Dissatisfied	-0.21**	-0.02
Admonishing	-0.15**	0.01
Strict	-0.10	0.18*
Multiple R	R = 0.39***	R^2 =0.15

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ n=313

6.4.1.4 Student Learning and Teacher-Student Interpersonal Behaviour

The simple correlation (r) data in Table 6.8 indicates that all associations between the value students place on learning and the QTI scales are statistically significant, except for the Student Responsibility and Freedom scale. Moreover, there are significant positive associations with the Leadership, Helping/Friendly and Understanding scales and negative associations with the Uncertain, Dissatisfied, Admonishing and Strict in relation to student learning. Thus, the positive influences on student learning can be attributed to teacher interpersonal behaviour that displays leadership, helping/friendly and understanding traits. The uncertain, dissatisfied and admonishing behaviour of teachers has a significant negative impact or decreases the importance that students place on learning. An examination of the student learning outcomes regression weights (β) indicate that only one of the seven scales retain their statistical significance. Thus teachers' leadership behaviours are most influential on students' motivation to learn science. The multiple correlation (R) statistic of 0.53 ($p<0.001$) indicates a significant association between teacher-student interpersonal behaviour and students' learning value aspect of motivation. The R^2 statistic indicates that 28% of the variance in students' learning can be attributed to their perceptions of teacher interpersonal behaviour.

Table 6.8

Significant Associations between QTI Scales and Student Learning Value in Science in terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scales	r	β
Leadership	0.50**	0.36***
Helping/Friendly	0.45**	0.15
Understanding	0.43**	0.04
Student Responsibility/Freedom	0.09	-0.02
Uncertain	-0.24**	0.10
Dissatisfied	-0.37**	-0.12
Admonishing	-0.26**	-0.01
Strict	-0.25**	0.03
Multiple R	R = 0.53***	R^2 =0.28

**p< 0.01 ***p<0.001 n=313

6.4.1.5. Performance Goals and Teacher-Student Interpersonal Behaviour

The final aspect of student motivation, the performance goals students set for themselves, was assessed in relation to teacher-student interpersonal behaviour. In Table 6.9, the simple correlation (*r*) data identifies four of the eight scales of the QTI as being positively associated with students' performance goals. With performance goals as the dependent variable, the Leadership, Helping/Friendly, Understanding and Student Responsibility and Freedom scales are statistically significant. Using the more conservative standardised regression coefficient (*β*) it is obvious that the Leadership and Student Responsibility and Freedom retained their significance, and the Strict scale became significant, thus having an impact on the level of students' performance goals. The multiple correlation was 0.38 which was statistically significant and the R^2 value of 0.15 illustrated that 15% of the variance in students' performance goals was indicative of their teachers' interpersonal behaviour.

Table 6.9

Significant Associations between QTI Scales and Performance Goals in Science in terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scales	r	β
Leadership	0.32**	0.31**
Helping/Friendly	0.27**	0.16
Understanding	0.24**	-0.01
Student Responsibility/Freedom	0.15**	0.13*
Uncertain	-0.11	0.02
Dissatisfied	-0.11	0.04
Admonishing	-0.10	-0.02
Strict	-0.02	0.19**
Multiple R	R =0.38***	R^2 =0.15

*p<0.05 **p< 0.01 ***p<0.001 n=313

6.4.1.6 The Effect That Student Attitude and Self-Efficacy has on Student Learning, Performance Goals and Achievement Goals in Science

It was the intent of this research to determine the effect that teacher interpersonal behaviour had on student motivation, attitude and self-efficacy in science. The previous sections in this chapter identified these relationships. It was of further interest to assess whether attitude and self-efficacy had any significant effect on the three aspects of student motivation. Fourteen questions posed in the SMASES under *Student Learning Value, Performance Goals and Achievement Goals*, enabled such associations to be identified. The simple correlation (r) data in Table 6.10 illustrate that all associations between students' attitude and motivation, and self-efficacy and motivation are statistically significant. An examination of the multiple correlation beta weights (β) also reveals that attitude and self-efficacy are positively related to all three areas of motivation, that is, student learning, performance and achievement.

In Table 6.10 the multiple correlation (R) statistic 0.66 ($p<0.001$) suggests that the effect of the three motivation scales on attitude is strong. The R^2 value indicates that 44% of the variance in students' attitude is explained by motivation.

Table 6.10
Significant Associations between SMASES Motivation Scales and Attitude in Science in terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

	Attitude	
	r	β
Student Learning	0.66**	0.60***
Performance Goal	0.42**	0.01
Achievement Goal	0.42**	0.10
Multiple R, R^2	0.66***	0.44

*** $p < 0.001$ n= 313

The effect that the three motivation scales have on self-efficacy is evident in Table 6.11. The multiple R statistic 0.50 ($p<0.001$) indicates that the effect of the three motivation scales on self-efficacy is significant. The R^2 value indicates that 25% of the variance in students' self-efficacy is explained by their motivation.

Table 6.11

Significant Associations between SMASES Motivation Scales and Self-Efficacy in Science in terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

	Self Efficacy r	β
Student Learning	0.47**	0.37***
Performance Goal	0.39**	0.17*
Achievement Goal	0.33**	0.01
Multiple R, R^2	0.50***	0.25

*** $p < 0.001$ n= 313

6.5 SUMMARY

Wubbels and Levy (1993) identified the importance of teacher interpersonal behaviour in the classroom and how it potentially effects students' motivation and achievement in science. Based on the significance of their assiduous research, this study provided another avenue to further elaborate on factors that influence students' perceptions of teacher interpersonal behaviour. Bandura (1977) instigated research into self-efficacy in a variety of settings and influenced by the findings of. Tuan, Chin, and Shieh (2005) an instrument to measure student motivation toward science learning which involved an analysis of student self-efficacy was specifically devised for this research. The SMASES proved to be a valid and reliable instrument to measure students' motivation, attitude and self-efficacy in science classrooms. Reliable and significant results using the QTI validated its use in this research as being an extremely useful tool in determining teacher interpersonal behaviour in science classrooms.

The next chapter draws together the findings of this research in relation to scale means and teacher typology. Conclusions are drawn in an attempt to identify teacher type that is considered to be most effective in the science classroom. That is, the type of teacher that promotes a motivated classroom environment where students adopt a positive attitude and a high level of self-efficacy. It also identifies associations with previous eminent studies. The applications of the results are reflected upon, with the intent of using the data in a tangible manner so that results can be disseminated to educators in junior science classrooms. It reflects on the effectiveness of utilizing the

QTI in conjunction with the SMASES to surmise relevant feedback to secondary school science teachers about teacher interpersonal behaviour and aspects of students’ perception of effective learning in the science classroom and the influence of teacher interpersonal behaviour on students’ desire to learn.

CHAPTER 7

RESULTS OF TEACHERS' USE OF QUESTIONNAIRES

7.1 INTRODUCTION

Findings about teacher typology that can be deduced from the data are considered in this chapter and aspects of student motivation, attitude to science and self-efficacy in science classrooms have been highlighted. Conclusions could then be drawn about teacher typology and its effect on classroom environment. Teacher differences, as perceived by students, are identified from the results of the quantitative data and reflect students' perceptions about the effectiveness of teaching in their science classrooms. Consequently, associations between motivation, attitude and self-efficacy and teacher type are then examined. Evidence is presented to suggest that teacher interpersonal behaviour has an influence on science students' motivation, attitude and self-efficacy. It is important to note the number of students who responded to the questionnaires for each teacher; Teacher 1, 80; Teacher 2, 103; Teacher 3, 50; Teacher 4, 55 and Teacher 5, 25. Conclusions are drawn to determine the most effective *teacher type* identified in this study and the significance of the quantitative research is presented.

7.2 STUDENTS' PERCEPTIONS OF TEACHER INTERPERSONAL BEHAVIOUR

7.2.1 The QTI and Scale Means

The scale means in Table 7.1 reveal that students perceived that their teachers were strongest in understanding (2.91), helping/friendly (2.86) behaviour, followed closely by displaying good levels of leadership (2.74). Students perceived their teachers as exhibiting low levels of uncertain (0.74), dissatisfied (0.84) and admonishing (1.37) behaviour and seldom allowing student responsibility (1.53) or being overly strict (1.81).

Table 7.1
Scale Means and Standard Deviations for QTI Scales

Scale	Scale Means	Standard Deviation
DC Leadership	2.74	0.74
CD Helping/Friendly	2.86	0.86
CS Understanding	2.91	0.76
SC Student Responsibility/Freedom	1.53	0.60
SO Uncertain	0.74	0.65
OS Dissatisfied	0.84	0.72
OD Admonishing	1.37	0.67
DO Strict	1.81	0.74

n = 313

7.2.1.1 Scale Means for Individual Teachers

In Table 7.2, the scale means for Teachers One, Three and Five indicate that their Helpful/Friendly behaviours were perceived as their strongest asset by their students. Teachers Two and Four displayed Understanding behaviours that were perceived highest by their students. The link between perceived leadership and strictness is interesting. Although Teachers Three and Five were deemed as displaying the strongest leadership qualities their students did not perceive them to be overly strict. In comparison, Teachers One and Two were perceived as being strict, however, their perceived leadership did not correlate with the level of strictness they displayed in the classroom. All five teachers' strengths were assessed as being strongest in leadership, helping/friendly and understanding behaviours, but they allowed for little responsibility and freedom in the science classroom. However, Teachers Three and Five appeared to display the most understanding. It was significant to note that all five teachers were perceived by their students as revealing little uncertain, dissatisfied or admonishing behaviour.

Table 7.2
Scale Means and Standard Deviations for Five Teachers in an Australian Study using the QTI

Scale	Scale Mean T1	SD T 1	Scale Mean T 2	SD T2	Scale Mean T 3	SD T3	Scale Mean T 4	SD T 4	Scale Mean T 5	SD T 5	F Value
Leadership	2.56	0.68	2.51	0.77	3.32	0.47	2.76	0.67	3.02	0.66	14.62 ***
Helping/ Friendly	2.65	0.83	2.40	0.91	3.48	0.47	3.16	0.53	3.49	0.49	27.30 ***
Understanding	2.57	0.75	2.70	0.82	3.33	0.51	3.19	0.52	3.42	0.39	18.19 ***
Student Responsibility/ Freedom	1.33	0.53	1.44	0.62	1.57	0.47	1.76	0.63	1.95	0.56	8.99 ***
Uncertain	0.84	0.74	0.87	0.70	0.39	0.42	0.69	0.59	0.63	0.45	5.86 ***
Dissatisfied	1.06	0.73	1.02	0.82	0.42	0.45	0.74	0.56	0.42	0.33	11.71 ***
Admonishing	1.88	0.74	1.30	0.59	1.15	0.42	1.12	0.54	1.07	0.54	20.65 ***
Strict	2.16	0.66	2.14	0.71	1.42	0.52	1.26	0.53	1.34	0.44	33.44 ***

*** $p < 0.001$

Table 7.2 allows for further scale relationships to be investigated on each teacher and valid assumptions to be drawn about their interpersonal behaviour. Teacher One displayed the most strict, admonishing and dissatisfied behaviours, the least understanding behaviour and gave little responsibility and freedom to the students in the science classroom. Teacher Two was perceived by the students to show the least amount of leadership and the lowest helping/friendly behaviour. Interestingly, this teacher was also deemed to be quite uncertain and dissatisfied.

Teacher Three was identified as the teacher with the highest level of leadership. It is evident that students perceived this teacher to be respected in relation to the helping/friendly behaviours that are displayed in the classroom. The students indicated that Teacher Three showed little admonishing, uncertain or dissatisfied behaviours. Teacher Four was the least strict, but showed an ability to be helpful/friendly and understanding. The mean scores for Teacher Five indicated that this teacher was the most helping/friendly and understanding. Students perceived that this teacher showed leadership and was the teacher who gave the students the most freedom and responsibility in the classroom compared to the other four teachers. They also viewed this teacher as being the least admonishing.

7.2.1.2 Statistical Differences Between Teachers Identified from the QTI

There are significant differences between students' perceptions of the five teachers on all QTI scales. Tukey's post hoc analysis showed the following for the scales of the QTI. For the scale of Leadership, Teacher 3 was a significantly better leader than Teachers 1, 2 and 4 ($p<0.001$) and that Teacher 5 was better than Teachers 1 and 2 ($p<0.01$, $p<0.05$). For understanding, Teacher 5 scored significantly higher than Teachers 1 and 2 ($p<0.001$). Teachers 1 and 2 were significantly lower than Teachers 3, 4 and 5 ($p<0.001$) in their understanding behaviours, as judged by students. For the Uncertain scale, Teachers 1 and 2 illustrated significantly more uncertain behaviour than Teacher 3 ($p<0.001$, $p<0.01$). It was statistically significant that Teacher 1 communicated more admonishing behaviour in the science classroom than any of the other teachers ($p<0.001$). Teachers 3, 4 and 5 exhibited distinctively greater amounts of helping/friendly behaviours than Teachers 1 ($p<0.001$) and 2 ($p<0.01$). It was also evident that Teacher 1 gave students less responsibility and freedom in the classroom than Teachers 4 and 5 ($p<0.001$). Teacher 2 was viewed as providing students with less responsibility and freedom than Teacher 5 ($p<0.01$). Teachers 1 and 2 were depicted by the students as being significantly more dissatisfied with students in the science classroom compared to Teacher 3 ($p<0.001$) and to Teacher 5 ($p<0.001$, $p<0.01$). The Strict scale indicated that Teachers 1 and 2 were decidedly more strict than Teachers 3, 4 and 5 ($p<0.001$).

7.2.2 Associations with Significant Studies

7.2.2.1 Scale Means

Similar results to those recorded in Table 7.2 were also reported in prominent studies pursued by researchers who have utilized the QTI and drawn valid conclusions regarding class means and the perceptions of teacher interpersonal behaviour (Fisher & Rickards, 2000; Fisher, Rickards, Goh, & Wong, 1997; Scott & Fisher, 2004).

The three scales of Leadership, Helping/Friendly and Understanding also rated strongly in all these three studies.

Scott and Fisher (2004) communicated the development, validation and application of a Malay translation of the elementary version of the QTI. Their scale means were strongest for Leadership (2.37), Helping/Friendly (2.36) and Understanding (2.22). Similarly, Fisher and Rickards (2000) reported on whether science teachers' perceptions of their actual teacher-student interpersonal behaviour are equivalent to the perceptions of their students. The scale means again indicated that students perceived teachers being strongest in the areas of Helping/Friendly (2.83), Understanding (2.83) and Leadership (2.74). Another conclusive study that assisted in confirming the usefulness and validity of the QTI was an investigation by Fisher, Rickards, Goh, and Wong (1997) that confirmed how effectual it is in comparing studies conducted in other countries. Their study encompassed examining interpersonal behaviour of Australian teachers in secondary schools' science classrooms, compared to those in Singapore. Their study acknowledged Australian students as perceiving greater Helpful/Friendly behaviours of their teachers with a scale mean of 2.84 compared to the Singapore scale mean of 2.69. It is relevant to note that in this researcher's findings, four of the five teachers had scale means ranging from 2.65 to 3.49 were also seen to have a scale mean of greater than teachers in Singapore. Again the same three scales proved to be interpreted as strongest with the Australian teachers scoring higher scale means than the teachers in Singapore.

These comparisons indicate that this researcher has also experienced success in determining that the QTI has been useful in comparing results from another country. It is particularly interesting to note that the researcher's scale mean for the Strict scale (Table 7.1) was 1.81 compared to the Singapore study recording 2.17. Thus, teachers in Singapore were perceived to be stricter than Australian teachers, they were also less uncertain 0.69 compared to 0.74 and gave students less responsibility and freedom 1.30 compared to 1.53 in this study.

7.3 ANALYSIS OF TEACHER TYPOLOGY

This research has been useful in determining the type of teacher interpersonal behaviour that students develop an affinity with, in relation to their enjoyment for learning in the science classroom. Previous data gathered using the QTI, enabled cluster analysis and teacher typology of interpersonal teaching styles to be constructed. In this study, interpersonal types can be compared to those initially devised by discernible researchers such as Brekelmans, Levy, & Rodriguez, 1993; Rickards, den Brok, & Fisher, 2003; Wubbels, Brekelmans, & Hermans, 1987.

7.3.1 Teacher Typologies

Students' perceptions about teacher interaction enabled the following constructs to be sketched. The manner in which these diagrams are formed from the QTI was explained in detail in Chapter 3. Three studies (Levy, Rodriguez, & Wubbels, 1992; Wubbels, Brekelmans, & Hermans, 1987; Wubbels & Levy, 1991) utilized the QTI to develop eight teacher typologies. Teacher communication typology diagrams appear below and the degree of shading is a measure of the height of the scale scores. Teacher behaviour styles for the five teachers in this study are illustrated accordingly, as well as the overall profile for the teachers in the science department. In line with the work of Wubbels, Brekelemans, and Hermans (1987), teachers can be categorized as one of the eight teacher types; Directive, Authoritative, Tolerant and Authoritative, Tolerant, Uncertain/Tolerant, Uncertain/Aggressive, Repressive and Drudging.

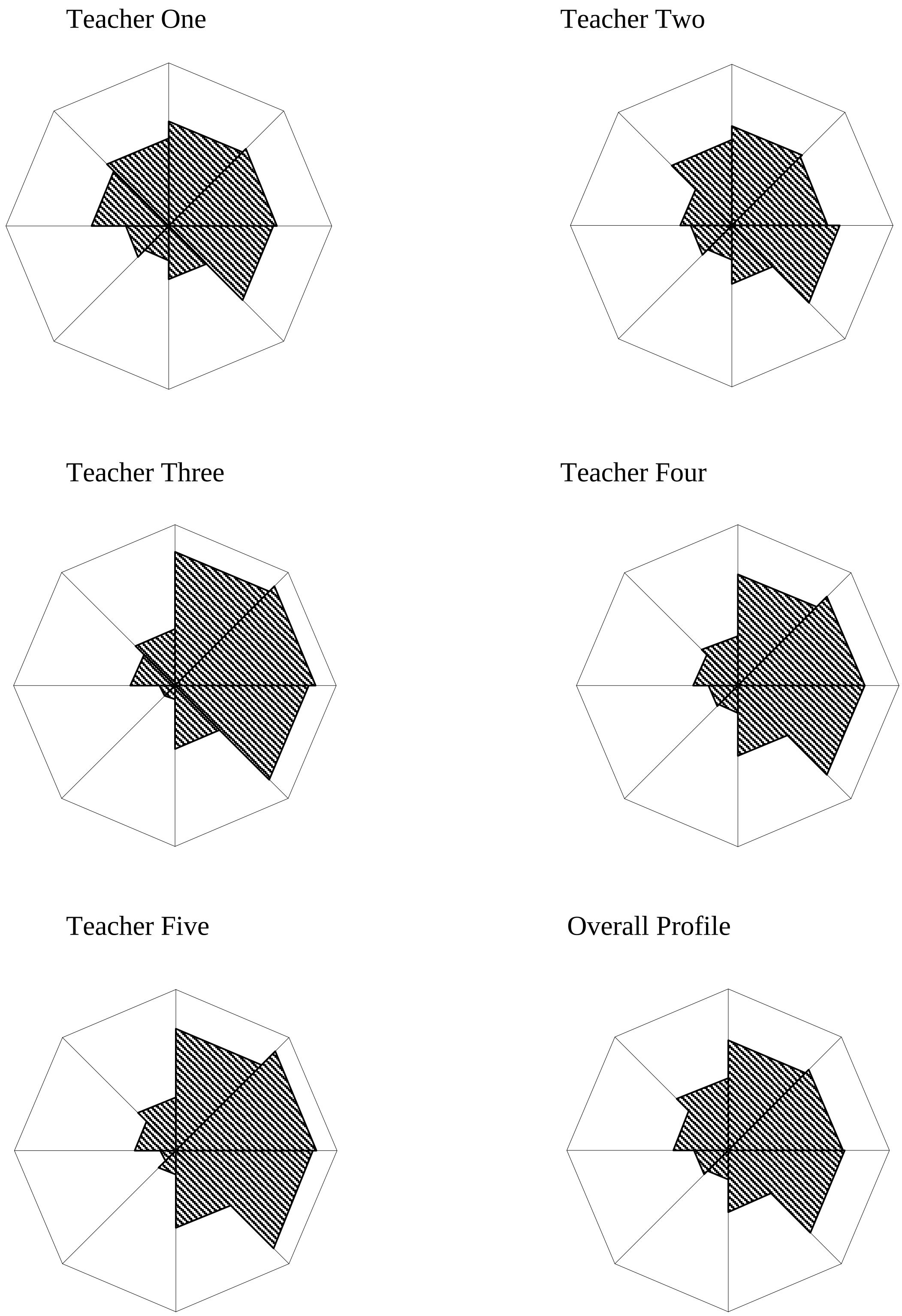

Figure 7.1. Teacher communication typology diagrams.

7.3.2 Associations with Previous Studies

Matching these typologies with previous studies (Brekelmans, 1989; Rickards, den Brok, & Fisher, 2003), it is evident that three teacher typologies could be identified in this study. Teachers One and Two are deemed to be ‘Authoritative’, Teachers Three, Four and Five, ‘Tolerant and Authoritative’. The overall profile for the five teachers indicated that the teachers in this study were perceived to be ‘Tolerant’. Wubbels, Brekelmans, and Hermans (1987) identified descriptors of teacher typology and those relevant to this study are elaborated upon below. Generally, the profiles suggest that the students perceive the learning environment to be pleasant in their science classrooms.

The authoritative atmosphere is well structured and task orientated. Teacher One and Teacher Two outline expectations as authoritative teachers and the students adhere to the routine. Students are attentive and the teacher is enthusiastic and open to students’ needs. This type of teacher is viewed in a positive light by the students and although lessons may appear to be delivered in a lectured format, they are planned well. The ‘Tolerant and Authoritative’ Teachers, Three, Four and Five create a variety of teaching methods that encourage student involvement and supports their responsibility and freedom. The teachers have a close working relationship with the students and this harmonious atmosphere appears to keep the students on task. The general learning environment is jovial and minor disturbances do not determine the tone of the lesson. Students focus on their goals and the goals set by the teacher.

It is important to note with this analysis that teachers can exhibit acceptable behaviour in each sector. Thus, there are situations in the classroom where it is appropriate for a teacher to be dissatisfied, uncertain or admonishing in their behaviour.

7.3.3 Australian Typologies for Teacher-Student Interpersonal Behaviour

Rickards, den Brok, and Fisher (2003) developed an Australian typology of interpersonal teacher behaviour. This venture drew on research completed in the Netherlands and in an American study. They found that the identified existing typologies were only partially applicable to the Australian context. In particular, they observed that tolerant, uncertain-aggressive and uncertain-tolerant types were less common in the Australian sample. However, authoritative and tolerant-authoritative types were apparent and happened to be the two teacher types identified in this study. Rickards, den Brok, and Fisher (2003) also deduced that there was a lower presence of uncertainty in Australian teachers' behaviour. Of considerable importance is the fact that teacher typology has been linked to student outcomes (Brekelmans, Wubbels, & Levy, 1993). Rickards, den Brok, and Fisher (2003) acknowledged that the highest motivation is found in classes of authoritative, tolerant-authoritative and directive teachers. Lowest motivation was identified in classes where teachers were drudging, uncertain and aggressive.

7.4 STUDENTS' PERCEPTION OF THEIR MOTIVATION, ATTITUDE AND SELF-EFFICACY IN SCIENCE

This study has inferred that teacher interpersonal behaviour plays an important role in cultivating students' perceptions of their level of motivation, attitude and self-efficacy in science. It was essential to statistically assess the impact that each teacher in this study had on students' overall impression of themselves as science learners.

7.4.1 The SMASES

The instrument used to assess students' motivation, attitude and self-efficacy, the SMASES, adequately allowed for extensive analysis of students' perceptions about themselves as learners in the science classroom. The calculation of scale means and Tukey's post hoc analysis enabled viable conclusions to be drawn about the usefulness of the SMASES.

7.4.1.1 The SMASES and Scale Means

Scale means for the five scales of the SMASES are presented in Table 7.3. Students answered the questions on a Likert-type scale (5 strongly agree to 1 strongly disagree). Generally the results indicated that students were highly motivated and had a positive attitude towards the subject. The scale mean of 2.93 illustrates that students perceive themselves to have a positive attitude towards science learning in the classroom. The Achievement Goal scale mean reached 3.99 indicating that students perceived a need to achieve in the science classroom; however, their self-efficacy is comparatively low, recording a scale mean of 2.80. The scale means also communicated a positive approach to student learning and an inbuilt desire to perform well in science.

Table 7.3
Scale Means and Standard Deviations for the SMASES

Scale	Scale Mean	Standard Deviation
Student Learning	3.66	0.69
Performance Goal	3.22	0.54
Achievement Goal	3.99	0.64
Attitude	2.93	0.95
Self-Efficacy	2.80	0.77

n = 313

Students display an innate ability to judge the proficiency of their teacher in the science classroom. In particular, they can perceive how effectual teachers can be in influencing a student’s enjoyment, their motivation and their level of self-efficacy in science. The scale means in Table 7.4 indicate that students found all five teachers to have a positive influence on their motivation with scale means ranging from 3.16 to 4.11. In particular, all five teachers’ major strengths as perceived by their students, was their ability to encourage students to strive to achieve, with scale means ranging from 3.93 to 4.11.

Students perceived Teachers Three, Four and Five to be the most effective in providing a motivated classroom environment in relation to their desire to learn, achieve and perform. Students found Teacher Three to be extremely effective compared to the other four teachers, in encouraging students to adopt a positive attitude towards their learning, recording a scale mean of 3.48. The attention to the promotion of student self-efficacy in the science classroom was a talent identified in Teacher Four with a scale mean of 3.03.

As discussed previously, Teachers Three, Four and Five exerted the highest levels of leadership, helping/friendly and understanding behaviours as perceived by their students. Interestingly, Table 7.4 indicates that Teachers Three, Four and Five are viewed as being significantly responsible for students developing high levels of self-efficacy. Again in reference to Table 7.2, it is noted that Teachers One and Two were seen to be the most strict, admonishing, dissatisfied and uncertain. Thus, it is poignant to note that students indicated that Teachers One and Two did not significantly influence students' attitude or self-efficacy. The fact that Teacher One and Teacher Two had less of an impact on students' motivation than the other three teachers, suggests that there is a relationship between leadership, helping/friendly and understanding qualities of a teacher and their ability to sustain motivation, encourage enjoyment and positively influence student self-efficacy.

Thus, there is a suggestion from the findings, that strict, admonishing and uncertain teachers have a direct impact of students' motivation, attitude and self-efficacy in secondary schools' science classrooms.

Table 7.4
Scale Means and Standard Deviations for Five Teachers in an Australian Study using the SMASES

Scale	Scale Mean T1	SD T 1	Scale Mean T 2	SD T2	Scale Mean T 3	SD T3	Scale Mean T 4	SD T 4	Scale Mean T 5	SD T 5	F Value
Student Learning	3.51	0.86	3.64	0.60	3.84	0.50	3.67	0.69	3.86	0.49	2.28
Performance Goal	3.21	0.65	3.21	0.55	3.16	0.43	3.25	0.50	3.31	0.41	0.38
Achievement Goal	3.95	0.72	3.93	0.62	4.00	0.49	4.11	0.65	4.07	0.65	0.93
Attitude	2.68	1.05	2.73	0.83	3.48	0.79	3.04	0.88	3.17	1.02	8.00 ***
Self-Efficacy	2.58	0.88	2.80	0.73	2.90	0.68	3.03	0.68	2.88	0.73	3.17 *

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

7.4.1.2 Statistical Differences Between Teachers Identified from the SMASES

A one-way ANOVA was conducted on the SMASES and significant differences between teachers were noted on attitude (p<0.001) and self-efficacy (p<0.05). Tukey's post hoc test analysis was also conducted on the SMASES. It showed that Teacher 3 has higher scores on attitudes than Teachers 1 and 2 and that these differences are statistically significant (p<0.001). In relation to self-efficacy, the only statistical significant difference is between Teachers 1 and 4 (p<0.01). The analysis indicates that Teacher 4 displays a greater ability than Teacher 1 to encourage students' self-belief in their ability in science.

Thus, there is conclusive evidence to suggest that students perceived that Teachers 3 and 4 displayed interpersonal behaviour that influenced students' attitudes and students' self-efficacy in science. The scale means calculated for the scales of the QTI and the SMASES, together with Tukey's post hoc analysis substantiates valid and reliable conclusions to be drawn about the use of the QTI in conjunction with the SMASES. Therefore, their usefulness to assess teacher interpersonal behaviour and its effect on influencing students' attitudes and self-efficacy in science has been verified in this research. However, from the statistical evaluation presented here, it is not conclusive that any particular teacher's interpersonal behaviour had more of an influence on students' motivation in the science classroom than another teacher. Although, students did rate certain teachers as more preferable in relation to aspects of their interpersonal behaviour that motivated them compared to other teachers.

The analysis presented here allows for conclusions to be drawn on the interpersonal behaviours as identified in the QTI and their influence on student attitude and self-efficacy in the science classroom that was assessed in this research. It is appropriate to identify the interpersonal behaviours of the two teachers who influenced either students' attitudes or self-efficacy compared to other teachers. Teacher 3 who was acknowledged as having a positive effect on students' attitudes to science compared to Teachers 1 and 2 displayed good levels of leadership, understanding and helping/friendly behaviours. Teacher 3 displayed low levels of uncertain, dissatisfied, admonishing and strict behaviours. Thus, it has been proven statistically that the combination of these attributes had a positive effect on students' attitudes towards science. Teacher 4 was distinguished as being significantly more effective than Teacher 1 in enhancing students' self-efficacy in science. Teacher 4 portrayed strengths such as, leadership, understanding and helping/friendly behaviours and gave students a reasonable amount of responsibility and freedom in the classroom. This teacher displayed low levels of admonishing, dissatisfied or strict behaviour. Thus, this profile of Teacher 4 suggests the capacity to influence student science self-efficacy in a positive manner.

7.5 SUMMARY

Substantial amounts of research investigating attitude to science and a variety of outcomes have been conducted over the years (Fisher, Henderson, & Fraser, 1995; Henderson, Fisher, & Fraser, 1998; Koul & Fisher, 2004; Wong & Waldrip, 1996). It was pertinent to this study that such influences on student learning and classroom environment were addressed. This study is unique in that it encompassed three variables, motivation, attitude and self-efficacy and examined if they are significantly affected by teacher interpersonal behaviour in science classrooms. This chapter highlighted the importance of three scales of the QTI, namely, Leadership, Helping/Friendly and Understanding as influential factors that affect student self-efficacy and attitude towards science in a positive way. It sought to identify relationships between students' perceptions of teacher interpersonal behaviour and its effect on how students perceive their level of motivation, attitude and self-efficacy in science.

The next chapter entails presenting the results of the qualitative research conducted in this study and delves into the minds of the students in order to seek their generalized views of their science teacher's interpersonal classroom behaviour. Their perceptions of their teacher were recorded in students' responses to the 48 items of the QTI and the 32 items of the SMASES. Students were given the opportunity to elaborate on their impressions of their teacher in an interview situation that provided them with an avenue to present their opinions, interpretations and analyses of their teacher's interpersonal skills. Their feedback assisted the researcher in explaining teacher typology and helped to analyze the usefulness of the QTI in liaison with the SMASES for examining science classroom environment.

CHAPTER 8

QUALITATIVE DATA ANALYSIS

8.1 INTRODUCTION

This chapter provides an analysis and evaluation of the qualitative data that were collected from students who were interviewed for this study. Thirty one students comprised the sample in this aspect of the research, that is, ten percent of the total number of students who responded to the QTI and the SMASES. The methodology involved in this section of research is outlined in some depth in Chapter 5.

The questions posed to the students (Appendix E) clearly sought to identify a range of factors being examined in this research. The analysis and evaluation of students' opinions provided evidence of a wide array of interpretations of their science classroom and factors that affect their learning. It also assisted in identifying common perceptions of students in different classrooms.

Students from the same class were interviewed in small groups in relation to science classroom environment and teacher interpersonal behaviour. They were specifically asked to comment on the effect that their teacher's interpersonal behaviour had on their attitude, motivation and self-efficacy in science. They also remarked on whether they thought that there was any association between teacher interpersonal behaviour and their impetus to achieve a good grade in science, and whether particular teachers made the classroom a more pleasurable place to learn.

8.2 STUDENT RESPONSES

8.2.1 Questions on the Science Classroom Environment

Students were asked questions that endeavoured to seek information regarding their perceptions of their science classroom environment. The questions posed were, 'Do you think your science classroom environment (atmosphere) is influenced by your teacher's interpersonal behaviour (the way in which he/she speaks and relates to the students)?' The second question that involved a reflection of the science classroom environment was, 'Is your science classroom a pleasant place to learn?' Students viewed these questions as an opportunity to air their views and responded quite positively in relation to their teacher's interpersonal behaviour and its effect on classroom environment.

Responses to the first question included:

> *Yes, she interacts with students pretty well and is always encouraging us to be inquisitive.*

> *This teacher is very helpful and having her, I want to proceed in doing science.*

> *When she came into the class it was all good, she was really kind of bubbly, but then she started losing control of the class and everything and no-one started paying attention. After a few days we all kind of understood that we could get away with things.*

The students identified the fact that there needs to be a balance between a teacher adopting a pleasant classroom manner and at the same time maintaining a firm control of classroom behaviour. Students also revealed negative views about teachers who used an aggressive classroom manner and, in turn, made students quite passive in the science classroom routine. For example:

> *But when she's kind of yelling at us, you kind of just zone out a bit and don't want to go to the next (science) lesson or do the homework or anything that she's asking you to do really.*

> *Yeah, it doesn't make us want to be there.*

> *She is very theory-based and quite boring…we get side-tracked.*

Students were responsive to lessons where a positive learning environment was created through the types of activities done in class.

> *If they interact with and let you do experiments.*

> *We always share stories and it got everyone involved.*

However, students more easily identified situations in relation to teacher interpersonal behaviour that created a negative classroom environment.

> *There was a really negative atmosphere, like we didn't want to be there, we were too scared to ask questions, because she would be like 'you're just stupid' or she would point you out, she never let you ask questions.*

Students were quick to highlight features of teaching techniques that inhibited their learning and made them judge their teacher's interpersonal behaviour on a regular basis. This in turn, led to negative impressions of particular classroom environments being formed.

8.2.2 Questions on Teacher-Student Interpersonal Behaviour

The initial question forwarded to students was one that endeavoured to seek information about teacher interpersonal behaviour and its affect on the science classroom environment. The question posed was, 'Do you think your science classroom environment (atmosphere) is influenced by your teacher's interpersonal behaviour (the way in which he/she speaks and relates to the students)?'

Numerous students found their science teachers to be pleasant enough in the classroom. Students were very aware of positive body language forwarded by the teacher and the teacher's general persona with comments such as:

She always had a smile on her face as soon as we came into the classroom, we got into work and it wasn't boring she made it fun to be there and everyone enjoyed it.

I think the teacher's interpersonal behaviour did affect the classroom environment. It made me want to come to science, even although I didn't like science. I think I enjoyed the class more than I did the subject.

Most students agreed that the science classroom environment is more pleasant:

If the teacher can make the lesson fun, interesting and can involve you somewhere (in the lesson).

However, they concluded that lack of teacher classroom control interfered with their learning and they then adopted a very casual approach to the subject. Students clearly disliked classroom environments where minimal learning was occurring. They were quick to identify classrooms where teachers lacked control and where a loud minority of students determined the atmosphere. Students became frustrated with teachers who could not explain things clearly, as well as those who then moved on to other topics too quickly adding to students' confusion in understanding the knowledge component of the course. Thus, a teacher's lack of class control was viewed by students as the avenue to 'tune-out.' Inevitably, they concluded that the teacher's interpersonal behaviour really did determine the classroom atmosphere. One student replied:

If we didn't agree with her we were wrong and the classroom environment atmosphere was negative and threatening, she was always mean about things and always found the bad side of a situation.

Students reflected on the lack of positive feedback from a teacher as a determinant of the classroom environment. Responses revealed the sensitive and emotional sides of students who sought positive reinforcement regarding their efforts.

> *She never congratulated you, or said good work, keep it up, she just put you down all the time.*

Another student was perturbed about the rate that concepts were taught, causing students to flounder in the classroom, yet they were reticent to bring this to their teacher's attention.

> *She rushed all the time, she didn't really explain things properly.*

Students found some teachers to be intimidating and consequently were 'too scared to ask questions, she kind of assumed you knew too much.' Students were not receptive to personal comments that insinuated that a student had little ability, for example:

> *I have a friend with learning difficulties and she (the teacher) put her down and called her stupid then everyone was scared to go to science because they thought they would be put down as well.*

Students were very protective of their peers' feelings believing that the manner in which a teacher spoke to students determined students' attitudes towards the teacher. One student believed:

> *Because she put down people in the class, and that made me think, well, she's not being nice to my peers so that made me like her less.*

Students were most critical of teachers who spoke to them in a condescending and aggressive manner.

> *She spoke to the class like we were expected to know what she was on about and I didn't. So yes it (teacher interpersonal behaviour) did affect the environment.*

8.2.3 Questions on Attitude Towards Science

It appeared evident throughout the interviews that students' attitudes towards science were affected by the types of learning experiences they were involved in and the teaching strategies that teachers used in the science classroom. The question that was asked that helped to draw valuable conclusions regarding this aspect of the research was, 'What types of teaching strategies and classroom activities influence your attitude towards science?'

Interestingly, students identified teachers' lack of disciplinary techniques to be a hindrance towards developing a positive attitude towards science. In particular, one student revealed 'she screams at you and then gets angry if you don't get it right, mainly in practical work.' It is ironic that the yelling at students is perceived by teachers to be the catalyst for making students pay attention; however, some students responded to this by saying 'you don't really pay attention (to the screaming) and just do whatever.'

Students also found that teachers' predictable classroom routine had an influence on their attitude towards science:

> *In all other work, all she does is just write on the board and all we do is copy it down.*

> *She would only ever ask people who were smart or people who were naughty.*

Teachers can inadvertently be quite predictable in their questioning techniques and this can affect students' enthusiasm for the subject. Sometimes, due to time constraints, may ask a student who is expected to know the answer, in order to cover the content of the course. Alternatively, students whose concentration is wavering can be brought back on task by being questioned by the teacher. Unfortunately, the quiet student who is of an average ability can be left to flounder in the classroom:

> *If you were a silent person, she wouldn't really ask you.*

Sometimes classroom routines can completely leave students perplexed:

> *If you didn't understand she wouldn't explain it or would explain it after the lesson, but by that time it was too late and I wouldn't get the whole lesson.*

Students also found it difficult to show interest in topics when the teacher completely lacked direction. One student relayed the lesson 'when she was talking about starfish and the topic was electricity.' Such deviation from a topic surely has the ability to cause disarray in the mind of the learner, changes the focus of the lesson and thus the attitude of the students. Another significant determinant of student attitude towards science was the perception students formed about a teacher's classroom manner.

> *My attitude personally hasn't changed because she didn't put me down that much …but my friend (who was put down) doesn't like science at all now.*

Other students revealed that their negative attitude towards science would never change due to unpleasant experiences and memories of science in primary school. One student suggested that the routine was so predictable that they were exposed to the same lesson format every time they had science. Others blamed the teacher's lack of classroom control to be the reason for their apathetic attitude towards science.

> *Well I know I've never been fantastic at science. But if I'm in a class environment where I can't understand and I can't hear properly because of all the people (their behaviour), my attitude just goes down and I don't want to try anymore.*

This type of comment is certainly quite detrimental to students' enthusiasm for science. It also causes concern in relation to why students may not choose to pursue science as a subject in the senior years at school. This issue led the researcher to investigate what actually motivates students to want to learn science. Teaching strategies that attempt to motivate students in science classrooms were then investigated.

8.2.4 Questions on Motivation to Learn Science

In relation to motivation in the science classroom, the questions that were posed were, ‘What types of interpersonal behaviour does your teacher show that motivates you to want to learn science?’ and, ‘Does you teacher’s interpersonal behaviour motivate you to want to achieve a good grade in science?’

It was apparent that students enjoyed the challenging aspects of practical work in science, that is, experiments. Some students found practical work as an escapism from the routine, particularly if the teacher was not pleasant, they saw it as an opportunity to ‘talk to your friends and ask them if you didn’t understand anything.’

However, they did not enjoy observing the teacher doing the experiments as demonstrations. Comments that displayed their opinions included:

> *When we did experiments, we never did hands-on sort of experiments. We were using paper and drawing tables.*

> *Most of the time it was her doing the prac and us watching. It would have been great and more out-there if we were doing the prac.*

Other students identified the continual use of overheads and a ‘chalk and talk’ mentality as stifling their enthusiasm.

> *Our teacher last year mainly used overheads. We’d mainly do like writing and stuff. But our teacher this year, she teaches us in a way that’s easier to remember. Instead of having pages and pages of notes you would have little flowcharts that were easier to memorize.*

Some students were quite observant of the classroom routine and noted in their response to this question that a pleasant environment didn't necessarily make them motivated to learn. Others noted:

> *I was motivated to better my results because of the environment.*

> *I pretty much motivate myself to do well in all the subjects I can, but when an environment in a classroom where a teacher is more pleasant, it makes it a lot easier to do the work and do it well.*

> *The environment was really good and happy, because she was really funny. But her attitude, she wasn't really disciplined with us, so that made me slack off a bit.*

Others agreed by adding:

> *I just didn't work very hard because I wasn't being told to work hard. She was a good teacher but I had no motivation to do anything.*

Other students commented on the fact that making the content easier to understand, as well as having classroom control, motivated them to work in science. Comments included:

> *You have to be kind of strict, you can't be too soft. But you've got to know when to use it (discipline).*

> *I think having a fun teacher (is good), but not having fun all the time, someone who's also serious.*

There appeared to be a feeling by students that teachers who did not portray a positive attitude in the classroom inadvertently passed that same apathy onto their students. Thus, students lacked motivation to work in particular classrooms. Responses that enabled these conclusions to be drawn included:

She would set us homework and the science homework was the last thing you would want to do, you would come to class the next day and she would completely forget that we had homework. So homework was really like, we didn't have to do it.

Students linked their efforts in science to the grade that they achieved and they saw this as a direct influence of the teacher's level motivational support. Thus in response to the question, 'Does you teacher's interpersonal behaviour motivate you to want to achieve a good grade in science?' typical responses included:

The previous teacher was very encouraging and she made me think that I was great at doing this and I performed well and I got great marks from her.

Others were influenced negatively:

I felt like it didn't really matter if I passed or not and I was getting bad marks because I wasn't being pushed to do any better.

She only focussed on some people.

Some students used the teacher's indifferent manner towards them as the tool for motivating themselves.

I really wanted to prove to her that I could do it, but other than that it didn't phase me at that stage...I was at a junior level of science, it didn't count for anything.

The teachers' direct comments regarding students' ability had a significant impact on students' motivation for science. Several students were adamant that these were the actual comments uttered by their teacher, 'that's what you got, that's what sort of student you are' and, 'you'll never improve.' Such damaging words were perceived by students as, 'she made you feel like you were no good and there was no chance of improving'. In particular classes, students felt there was no reason to be motivated because the teacher was rude and, 'she didn't do that much in class to motivate us so we had to do it ourselves.' Disturbingly, students who felt neglected in the classroom were purely motivated to achieve a better mark, 'to prove her wrong.'

Students also believed that their decision not to pursue science in senior school determined their effort in class and their teacher's belief in their ability.

> *She probably had an idea that I wasn't going to do senior science so her attitude wasn't as positive towards that side of the classroom. Other people who were definitely going to be doing it, she had more enthusiasm and attention based on them.*

Thus, students' impressions of their teacher's attitude towards them had some effect on students' attitude towards science as well as their academic self-efficacy.

8.2.5 Questions on Self-Efficacy in the Science Classroom

In relation to student self-efficacy in the science classroom, the questions posed included, 'Do you believe that your teacher's interpersonal behaviour affects your self-efficacy (self-belief in your ability) in science?' 'Do you believe that students work harder in science depending on who they have for their teacher?' and, 'Is your teacher encouraging of your efforts in the science classroom?' At times, responses to these questions seemed to overlap with the students' perceptions of students' attitudes and students' motivation. Students' impressions of their self-efficacy levels appeared to be directly influenced by the type of feedback, if any, they received from their teacher. For example:

> *I thought I was doing quite well, because after class she'd come up to me and say, 'Oh you're doing really well, you're working really hard and your grades are going to improve.'*

> *I think she made everyone feel equal. She didn't treat anyone as if they were dumb. She treated us all the same. She made me feel equal and worth teaching.*

Again student opinion unearthed almost a payback type routine in relation to justifying students' classroom behaviour. One student justified her efforts in science by stating:

> *She never gave you positive feedback. So we thought, she doesn't give us attention, so what's the point of paying attention in her class.*

However, students appeared to be quite responsive to teachers who did not make them feel academically subordinate:

> *If we didn't get something, she would explain it until we got it, she didn't make us feel dumb or anything.*

This is surely one of the most influential factors on productive student learning, making the students feel as though they are worth teaching. In turn, they become more enthused and less inhibited in their quest for knowledge in the science classroom. Responses such as these, led the researcher to believe that students' self-pride was somehow influenced by teacher interpersonal behaviour. Students stated:

> *I've had this teacher in other subjects and so I wanted her to have a good opinion of me and my grades, and she always made you feel superior and as good as everyone else.*

Another important factor in student learning is to understand how they absorb information. Naturally, most students require direction regarding their focus and interest levels. Students looked to their teachers for guidance stating:

> *I wanted to work for this teacher, she made it interesting for me, and when I'm interested, I'll get a better grade because I'm willing to learn.*

Other teachers were referred to by students as good because they directed students' learning and they 'tell us how to write it down.' Students were very critical of teachers who could not explain things clearly; whether it be the content aspect of the course or the lack of instructions they received for practical work. Students' self-efficacy appeared to deteriorate because they could not understand the set task and gradually became increasingly doubtful about their ability.

> *I think my self-belief did go down because throughout the course, just the way everyone was spoiling her teaching, kind of thing, it just didn't seem to work.*

> *The things she said didn't make sense, so we couldn't do the experiments properly. And then she'd move on to the theory which no one understood in the first place.*

> *Definitely a lot of people tuned out because we didn't think we could get the answer the other classes were able to get because we hadn't been taught properly.*

It became evident throughout this research that students were very responsive to teachers who were positive and encouraging. They noted that their grades improved as they were more inclined to work for someone who displayed genuine empathy. They appreciated teachers who did not humiliate students in front of their peers by stating, for example:

> *She would come over and help you one on one, because in front of other students I wasn't that confident.*

They also referred to teachers in a positive light when they:

> *Didn't focus on the negatives…she made me feel a lot better about myself.*

Others agreed and said:

> *She'd definitely pick out the good bits of what you did and still give you hints about how to improve.*

In contrast, students were adamant that they can perceive that:

> *Some teachers don't want to help you and when they don't want to help you, you don't want to do any work (for them).*

As well as teachers influencing students' learning, students also recognized the fact that if their peers were hard working, their work ethic would influence their efforts in the science classroom:

> *All of my friends wanted to get good marks as well, so I studied a lot more.*

> *With a positive teacher I study a lot more.*

> *Teachers have to be nice, they've got to be able to explain things properly to you and they've got to be able to control the class.*

8.3 SUMMARY

This presentation and analysis of the salient issues revealed in the qualitative data, proved to be a most fruitful manner in which to ascertain a level of understanding of students' perceptions of their teachers in science classrooms. Generally, students viewed their science teachers to be amicable and the classroom environment to be quite pleasant. However, they were critical of teachers who lacked control of student discipline, as they feared that this interfered with their learning opportunities. They identified the fact that students are more receptive to learning if the environment encouraged student involvement. Thus, they inferred that a teacher's classroom manner significantly contributes to the classroom environment.

In relation to students' perceptions of teacher interpersonal behaviour, students were most responsive to teachers who showed empathy in the classroom, who had firm classroom control and a positive, confident and inviting manner. They viewed the teacher's capacity to sense when students were not coping academically in class as an important aspect of teacher interpersonal behaviour. That is, they identified with teachers who positively reinforced students' efforts. In comparison, they did not respond well to teachers who could not explain the content clearly, those who were abrupt and those who made students feel threatened and therefore, apprehensive to ask questions in class. Teachers who showed aggression tended to make students feel isolated in class and caused students to become quite indifferent to participating in the lesson.

Students believed that their attitudes towards science were formed via their learning experiences in the classroom. In particular, they adopted a more positive attitude towards learning science when they were directly involved in the practical work and when the teacher adopted a variety of teaching strategies that kept the students enthused. Again students believed that their teacher's manner was primarily responsible for shaping students' attitudes towards science. Derogatory comments from teachers were seen as being detrimental towards students' attitudes in the science classroom.

Students felt that motivation in the science classroom was also determined by the frequency of practical work. They were also motivated to learn when the when the teacher exerted efforts to cater for all students' learning needs in the classroom. They appreciated and were motivated by teachers who used a variety of teaching strategies that made the content easier to learn. They noted that if teachers were pleasant, the students were more motivated to learn from that particular teacher. However, if pleasant teachers lacked classroom control, students became quite idle in the classroom.

Finally, students felt that if they were prematurely judged by teachers regarding their academic ability, their self-efficacy declined and they were very reticent to exert themselves in set tasks. Students believed their self-efficacy was influenced by direct feedback they received from their teacher. That is, the teacher proved to be of significant importance in building and shaping students' academic self-efficacy by the way in which they communicated with the students.

In the final chapter, the researcher reflects on the impact that this investigation will have on improving teacher-student interpersonal relations in the classroom. The chapter will present an overview of significant findings and assess the worthiness of this research. It will also identify the impact that teacher's interpersonal behaviour has on student motivation, attitude and self-efficacy in science classrooms.

CHAPTER 9

CONCLUSION

9.1 INTRODUCTION

This thesis has culminated in the presentation of explicit findings about students' perceptions of teacher interpersonal behaviour and its effect on student motivation, attitude and self-efficacy in the science classroom. Students from an Australian private secondary girls' college in years 8, 9 and 10 completed two surveys, the Questionnaire on Teacher Interaction (QTI) and the Students' Motivation, Attitude and Self-Efficacy in Science (SMASES) questionnaire. The application of the QTI in this study, enabled students' perceptions of teacher interpersonal behaviour to be gathered. The SMASES sought to obtain information about students' motivation, attitude and self-efficacy in science. The QTI was validated for use in secondary school science classrooms, as was the SMASES. Associations were able to be deduced about aspects of the QTI that helped to decipher what types of teacher interpersonal behaviour directly influenced students' motivation, attitude and self-efficacy in science. Thus, this research is effective, in that for the first time it presents the feasibility of using the QTI in conjunction with the SMASES to assess teachers' impact on students' receptiveness towards science. Comparisons of teachers' interpersonal behaviour and its effectiveness on student motivation, attitude and self-efficacy as perceived by students, evinced that students are most receptive to teachers who display understanding, helpful/friendly and leadership qualities in the classroom.

This study certainly alerts teachers to the perceptiveness of young adolescents. Such research offers avenues by which teachers can reflect upon ways in which they can modify their interpersonal behaviour in order to increase, re-direct or challenge students' motivation, attitude and self-efficacy. It is a distinctive study by the manner in which it identifies viable means for teachers to better manage their classroom environment. It is evident from this research that deterioration in teacher-student relationships in the classroom can repress students' enthusiasm for science. This research has delved into the reasoning behind students' interpretations of how aspects of their classroom demeanour can be determined by teacher interpersonal behaviour. The qualitative component of this study allowed students to qualify their impressions of their teachers and explain their own levels of behaviour.

It has also been established in this research, that a lower self-concept will inevitably lower one's motivation to achieve. This observation is substantiated by acclaimed researchers, 'for children who do not perceive themselves as highly able, this combination could result in a lower self-concept of ability and less motivation to achieve' (Midgley, Eccles, & Feldlaufer, 1993, p. 119). It was also predicted by these researchers, that students perceive their high school teachers to be less caring, warm, friendly and supportive than primary school teachers, and that this in fact could have a negative impact on students' motivation in the science classroom. 'This deterioration in the student/teacher relationship as young adolescents move to the junior high school does indeed have a dampening effect on their attitudes toward mathematics' (Midgley, Eccles, & Feldlaufer, 1993, p. 119). It was apparent when analyzing the qualitative data, that students were very aware of teachers who appeared to be blatantly admonishing in the classroom. The disharmony that this caused was perceived by students to be hampering their interest in learning.

9.2 MAJOR FINDINGS OF THE STUDY

The specific intent of this research was to pursue students' perceptions about teacher interpersonal behaviour and determine if certain types of behaviour affected students' motivation, attitude and self-efficacy in science. Relevant statistical analyses enabled salient conclusions to be summated. Research on teacher interpersonal behaviour has presented findings that suggest that teacher-student communication patterns develop early in the school year and then remain stable over time (Wubbels & Levy, 1993). Thus, this research highlighted that it is imperative for teachers to establish a harmonious and workable learning environment when the school year commences.

The questions presented in Chapter 1 are now able to be answered here due to the comprehensive quantitative and qualitative investigations carried out and reported in Chapters 6, 7 and 8.

Question 1: Are the QTI, SMASES questionnaires reliable and valid for assessing teacher interpersonal behaviour, student self-efficacy, student motivation and enjoyment in science in Queensland Private Schools?

This study has forwarded evidence that the QTI and the SMASES can be used confidently as classroom environment instruments. With reference to Tables 6.1, 6.4, 7.2 and 7.4, both instruments revealed satisfactory levels of reliability and validity. The QTI scales were able to differentiate between classrooms and the circumplex nature of the scale arrangement of the QTI was also verified. That is, opposing scales correlated negatively and adjacent scales correlated positively (Figures 6.1 and 6.2). The qualitative data assisted in interpreting the quantitative findings of the QTI and the SMASES.

Question 2: What associations are there between students' perceptions of their teacher's interpersonal behaviour and their motivation in science?

The three areas of motivation addressed in the SMASES, Achievement Goals, Student Learning and Performance Goals were influenced by students' perceptions of teacher interpersonal behaviour. These results were highlighted in Tables 6.7, 6.8 and 6.9 and suggested that students' achievement goals were positively influenced by teachers' leadership and strict behaviours. Student learning was significantly influenced by the depth of leadership teachers exhibited in the science classroom. Performance goals by students were influenced by the quality of teacher leadership, the perceived amount of student responsibility and freedom teachers provided for their students and by teachers' strict behaviours they illustrated when controlling the class.

Question 3: Are students' self-efficacy levels determined by a particular 'type' of teacher, as identified by the QTI?

This research identified the *Tolerant and Authoritative* teachers to be the most productive in promoting student self-efficacy. The qualitative research allowed students to justify their opinions forwarded in the SMASES and the QTI. They believed that teachers had the capacity to affect student self-efficacy. They emphasized the fact that teachers who included all students in the class, who did not make them feel academically challenged ('stupid') and who provided them with positive and encouraging feedback about their efforts were viewed as having a positive impact on student self-efficacy. All the QTI scales proved to have a significant influence on student self-efficacy. In particular, teachers who were regularly displaying strong levels of leadership had a telling impact on students' levels of self-efficacy. Not surprisingly, teachers who were incessantly admonishing had a significant influence on lowering student self-efficacy.

Question 4: What teaching strategies, as identified by students, are used by teachers who are able to enhance student motivation in science?

The qualitative research, in the form of student interviews, was most beneficial in identifying students' opinions about the suitability of certain types of teaching strategies that encouraged their motivated participation in science lessons. Students were most receptive to strategies where they were involved with performing experiments. They also believed that the teacher's ability to relay relevant stories designed to enhance student understanding of a concept to be most supportive for their learning. They viewed teacher stories as a means to solidify their understanding of the topic and also creating an opportunity for all students to be involved in classroom discussion. Students expressed a desire to experience fun in science that inevitably encouraged involvement and a positive attitude towards learning. Students identified the use of flowcharts as being extremely useful for aiding the understanding of the topic as a whole.

Students expressed they had an aversion to teaching strategies that precluded their use of experiments. They felt that they were more passive in class when the teacher performed practical work as a demonstration. They also disliked copying information from overheads that were not supported by adequate teacher explanation. The underlying theme from students' responses clearly demonstrated their desire for a more positive and accommodating classroom environment that they believed is determined by a teacher's pleasant disposition.

Question 5: What associations are there between students' perceptions of teacher interpersonal behaviour and their enjoyment of science?

Students' attitude scores were higher in classrooms in which students perceived greater leadership, helping/friendly and understanding behaviours in their teachers. It was evident in this study that when teachers exhibited uncertain, admonishing, dissatisfied and strict behaviour, students' attitudes were less positive.

Question 6: What associations are there between students' motivation in science and their enjoyment of science?

The simple correlations appearing in Table 6.10 indicated that in this study, all three areas of motivation positively influenced students' attitude towards science. The multiple correlations suggested that student learning significantly affected students' attitude towards science. Positive associations were identified with all associations between students' attitude and motivation, and self-efficacy and motivation of which all are statistically significant.

Question 7: What associations are there between students' motivation and their self-efficacy in science?

Motivation was also viewed as an important consideration in affecting self-efficacy. Specifically, the multiple correlations indicated in Table 6.11 illustrated that the student learning component of motivation significantly influenced student self-efficacy.

Significant conclusions have been drawn from the quantitative data in Chapters 6 and 7 and the qualitative data in Chapter 8. This study has enabled comparisons between teachers in relation to the effectiveness of their unique interpersonal behaviour and their ability to influence students' in a positive and encouraging way in the science classroom. In fact, this study acknowledged the teacher who promoted a sense of worth in students and who affirmed students' efforts. These teachers were viewed in a positive light by the students. Students also ascertained that teachers who displayed leadership qualities, were helping/friendly and revealed understanding behaviour were more able to promote enjoyable learning experiences in the science classroom.

In summary, as well as the extensive quantitative analysis, valuable feedback from students regarding factors that they believed to be a hindrance to their genuine enjoyment of science were also obtained. This research has identified the students involved in this study as receptive learners who were sensitive to admonishing teacher behaviour. Their motivation, attitude and self-efficacy in science were significantly enhanced by teachers who illustrated high levels of leadership, helping/friendly and understanding behaviours.

9.3 IMPLICATIONS OF THE STUDY

9.3.1 Teacher use of the QTI and the SMASES in Junior Science Classrooms

By creating awareness about the significance of classroom environment instruments, this study presented validation of the QTI and the newly constructed SMASES. Science teachers have an option to access these instruments with confidence in order to identify the types of teacher interpersonal behaviour that promote a positive and enjoyable learning environment. In particular, further studies that utilize these instruments concurrently, can also evaluate with accuracy the types of teacher interpersonal behaviour that students most favourably respond to in the science classroom. This study illustrated that students were most responsive to teachers who demonstrated leadership, helping/friendly and understanding behaviours. Students identified teachers who were admonishing as having little impact on effective classroom learning. Teacher interpersonal behaviour was viewed as playing a significant role in students' attitude, motivation and self-efficacy in the science classroom.

The collation of specific teacher typologies provides invaluable feedback to teachers who wish to reflect on how their classroom behaviour is interpreted by their students. The typologies that are identified may simply ratify teachers' understanding of their interpersonal behaviour or inform them of undesirable behaviours that students have identified during the classroom routine. If the latter is the case, the nature of teacher typology feedback enables teachers to rectify behaviours that are deemed to be unsuitable for encouraging valuable learning in junior science classrooms. Another reason to use these two instruments in science classrooms would be to evaluate the impact that the current curriculum and teaching strategies have on student motivation, attitude and self-efficacy. This study identified three of the five teachers as 'tolerant and authoritative' in the science classroom. These same teachers were seen to display leadership qualities, were helpful, friendly and understanding all of which were contributing factors conducive to promoting the enjoyment of learning science.

The implications of this study are pertinent to teachers where the typology can provide valuable feedback to them regarding how students perceive their communication style, as well as providing instant feedback about how students view the learning environment. Sector profiles can be used to determine relevant staff professional development specific to individual teacher needs. Professional development opportunities could be created to focus on how to create specific classroom environments. Particular to this research, in-service opportunities could be provided that address strategies about how to increase levels of leadership, helping/friendly and understanding behaviours in junior science classrooms. Science teachers could also use the results of the QTI to examine how students' impressions of their teacher interpersonal behaviour affected student achievement outcome. Results from the QTI could also be used to assess staff suitability for particular classes or students with specific learning or emotional needs.

After reflecting on this research, teachers would be advised to adopt rigorous lesson planning that utilizes specific strategies that promote a positive learning environment. They should strive to display a classroom manner that exudes leadership, helping/friendly and understanding behaviours. At the same time, flexibility in the curriculum that caters for all students' learning needs is essential in order for students to develop a positive and motivated attitude towards science and continue to realize the effect that self-efficacy has on enjoyment in the science classroom. Students strongly expressed a desire for more experiments to be incorporated into their science lessons. Therefore, teachers should be amenable to any restructuring of the curriculum in order to accommodate more enjoyable learning experiences. Such changes into the general lesson routine have the potential for students to view their teachers' efforts in the classroom in a more positive light. For example, experiments allow for students to grasp a better understanding of the knowledge component of scientific concepts. Therefore, it is advisable, from evidence in this study, that students' hands-on experience should instill greater levels of enjoyment in science and consequently a more enthusiastic approach to studying science.

9.3.2 The Effect the Findings have on Teaching Strategies

This research has utilized the two classroom environment instruments in order to firstly, ascertain if teacher interpersonal behaviour can be identified in junior science classrooms; secondly, to identify the types of science teachers who are able to inspire active learning in science classrooms and thirdly; to substantiate the effect that teacher interpersonal behaviour has on student attitude, motivation and self-efficacy in science.

The results are conclusive, having identified teachers who display high levels of leadership, helping/friendly and understanding behaviours, to be the most effective science teachers. However, it is advisable that teachers do not become complacent about their students learning needs and continue to strive to better equip themselves with teaching strategies that accommodate all science students' learning needs regardless of ability. Science must be promoted as a learnable subject in which students can attain their potential. Intrinsic motivation is certainly an attribute that contributes to success in any subject. However, it is imperative that science teachers reflect on the impact they have on advancing students' potential and endeavour to create a classroom environment that promotes lifelong learning.

Marzano and Pickering (1997) developed a new innovative method of teaching that involves implementing *Dimensions of Learning* (DOL) strategies into experiences of classroom learning for students. DOL promotes the fact that students can become independent and reflective learners by using strategies designed for their specific learning needs. Since this research began, DOL strategies have been implemented into junior science lessons in the private school involved in this study, with the intention of developing students' understanding through a variety of self-reflective learning experiences. There are a plethora of suggested strategies that promote teachers as leaders who are helping/friendly and understanding. There are strategies that are designed to reach a wider range of learners and encourage a more accommodating curriculum. Thus, there are greater opportunities available to develop students' potential. Marzano and Pickering (1997) identified the five dimensions of learning as ways that teachers can help students develop positive attitudes and perceptions towards learning; enable students to acquire and integrate knowledge; allow students to extend and refine their knowledge, encourage students to use their knowledge in a meaningful manner and assist students in developing productive habits of mind.

It should be the mission of educational researchers and teachers to seek ways to improve learning experiences for all students. This research can hopefully assist in alerting teachers to create more effective classroom experiences for their students and reflect on the quality of their current classroom teaching. This study created an opportunity to reevaluate one's career choice and provide essential feedback to teachers who have become complacent with their teaching techniques and creativity in the science classroom. Such self-reflection should permit one to create a more pleasant classroom environment that is more conducive to learning and one that motivates all students. Ultimately, this study provided thought-provoking answers to the question, what type of teacher interpersonal behaviour enhances various aspects of student learning in science.

Ultimately, this study enables teachers to reflect on evaluating students' perceptions and managing ways to alter their classroom environment to suit a wider array of learning needs. Teaching strategies and teacher efforts must be extended to promote extrinsic motivation if intrinsic motivation does not exist within the student. Students' experiences at a junior science level have a significant impact on whether or not they will continue to study science in the senior school. Classroom environment assessment provides a means of monitoring, evaluating and improving science teaching and curriculum. It is extremely important to consider the fact that students differ in the way they learn. Thus, student learning styles must be addressed when investigating effective teaching strategies. Teaching strategies must cater for the wide array of abilities, motivation, self-efficacy levels and attitudes in the science classroom. Without such delicate issues being addressed, all good intentions may impede constructive learning and decrease motivation, if the learning strategies do not cater for the learning styles of individual students. Teachers should develop a good rapport and a genuine empathy towards their students' needs, if science is to be promoted in a positive light. Such an approach will inevitably make the learning process in science more accessible to students of all abilities.

9.4 LIMITATIONS OF THE STUDY

Although significant findings have been reported in this research that validate the use of the QTI and the SMASES, it was unfortunate that only one private school was willing to allow their students to be involved in this investigation. The small sample size may not be a true representation of all private school students' perceptions of science teachers' interpersonal behaviour. The confidentiality of results was assured; however, schools that declined to participate may have been threatened by what they saw as potentially intrusive research. One could question whether the results may have differed if the study was conducted in a government school, a co-educational environment or in senior science classrooms.

A second limitation to this particular research was the fact that one of the teachers involved on the study was employed on a contract basis and in the eyes of the students did not have any real empathy with them or affinity with the school. The perceptiveness of the students may have had some impact on their views of this teacher's interpersonal behaviour. They identified this teacher as being the most admonishing and the one who 'lectured the content' of the course with no real interest in whether the students' learning needs were being met. This teacher was also classified as authoritative and the curt manner witnessed in the classroom by the students as revealed in the qualitative research, did little to motivate them or encourage a positive attitude towards science. As previously mentioned, it may be useful to conduct studies in junior science classrooms to determine the type of teacher that students believe show leadership, helping/friendly and understanding behaviours in the classroom. This would enable employers to interview potential employees with these interpersonal attributes in mind.

Another limitation was the fact that the school in this study operated on a semester rotation of teachers who would repeat the same unit to another group of students. This may have posed problems for the teachers involved as well as the students. It was noted in the qualitative research that students were at times reticent to form generalizations about teachers they had only had for a few weeks, and based their opinions on first impressions. From the teachers' point of view, they re-taught the same content to a new group of students and they may have inadvertently become less innovative and gradually lacked enthusiasm for the topic. Thus, students may have perceived such teacher apathy as the teacher lacking leadership or understanding in the science classroom. Curriculum organization, therefore, may have an impact on determining students' perceptions of teacher interpersonal behaviour. Teachers may have been teaching units they were not comfortable with in relation to their knowledge base. In fact, they may have revealed different or even more favourable interpersonal behaviour if they had been teaching units with which they felt more competent.

It may have benefited these findings if the questionnaires were answered a second time at a later date by the same students when a different topic was being taught to the class. This would have enabled conclusions to be drawn about whether the content being taught influenced students' perceptions of teacher interpersonal behaviour. This would enable students to express their opinions when they may have been studying an easier topic or when the teacher was more confident with the topic being delivered. Thus, inadvertently, teachers may portray a negative frame of mind if they are not confident with the knowledge component of the course. Students may even express their dislike for a topic by inaccurately analyzing their teacher's interpersonal behaviour as the cause for their disinterest, when in fact it could be the topic itself.

Another limitation to this study could be that the science classes involved were not streamed in relation to their academic ability. This may have had some bearing on the authoritative teachers being seen in a negative light. It may have been advantageous to correlate the results of the QTI, the SMASES and the qualitative data with student academic achievement level. This would have enabled conclusions to be formulated about whether student achievement in science had any impact on their perception of teacher interpersonal behaviour.

9.5 SUGGESTIONS FOR FURTHER RESEARCH

This study has alerted science teachers to the fact that the manner in which they conduct themselves in the science classroom may or may not be beneficial to promoting student motivation, self-efficacy, learning or enjoyment of science. Students divulged their perceptions about the most effective teachers in their junior science classrooms through lengthy interviews. They indicated that teachers who showed leadership qualities, were helping/friendly and understanding promoted a positive classroom environment. They also deduced that teachers who were admonishing, uncertain and dissatisfied did little to inspire student learning.

On this occasion, teachers' perceptions about their own interpersonal behaviour were not sought. On reflection, it may have been beneficial to assess teachers' feedback via the QTI and the SMASES in order to gain an insight into teachers' impressions of their own interpersonal behaviour. This assumption gives rise to potential further investigations where teachers could also be involved in the qualitative research and endeavour to justify their behaviour as perceived by their students. An analysis could then be conducted after individual teachers were alerted to the quantitative and qualitative results and recommendations could be forwarded to assist them acquiring more appropriate teacher interpersonal behaviours.

This research provided the cornerstone for further science classroom environment research in relation to motivation, self-efficacy and attitude. Further research could involve access to student achievement records in an attempt to identify correlations with student motivation, self-efficacy and attitude. It would be beneficial to determine whether high achieving science students viewed teacher interpersonal behaviour differently than average students and, whether high achieving students thought their teacher had any impact on student motivation, self-efficacy and attitude towards science. Also it would be worthwhile investigating, whether teacher interpersonal behaviour directly affects students' achievement. That is, do students exert themselves more for teachers with who they develop a good rapport and, therefore, whether student academic performance is directly affected by teacher type.

Further research could investigate students who currently study science in years 11 and 12 and determine how their perceptions of their science teachers' interpersonal behaviour compared to their perceptions of their teacher who only taught junior science classes. It would also useful to identify students who participated in the qualitative aspect of this research and determine why they chose to pursue science in years 11 and 12. It would be valuable to know if their junior science teacher was the impetus for them pursuing science at the senior science level.

9.6 FINAL COMMENT

It is anticipated that the findings in this thesis will engender enthusiasm into further research on teacher interpersonal behaviour and its effect on student motivation, self-efficacy and attitude toward science. Pertinent findings in relation to teachers in science classrooms were able to be deduced with the aid of the two valuable instruments utilized in this study, the QTI and the SMASES. This research proved to be valuable, particularly as it has allowed for self-reflection and a re-assessment of one's own teaching weaknesses and strengths. It is essential that as teachers, the communicators of knowledge, we are receptive and adaptable to the learning needs of students. By adopting a dedicated approach to the daily classroom routine and developing leadership, helping/friendly and understanding behaviours, as identified in this research, science students should become more motivated, have a more elevated sense of self-efficacy and adopt positive attitudes towards learning science.

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Questionnaire on Teacher Interaction (QTI)

STUDENT QUESTIONNAIRE

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

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

	Never				Always
This teacher trusts us	**0**	**1**	**2**	**3**	**4**

If you think that your teacher always trusts the class, circle the 4. If you think your teacher never trusts the class, circle the 0. You can also choose the numbers 1, 2, and 3, which are in between. If you want to change your answer, cross it out and circle a new number. Make sure you answer <u>every</u> question. Thank you for your cooperation.

Please complete the following details below before commencing the questionnaire.

Student name: ______________________________

School: ______________________________

Grade: ______________________________

Teacher: ______________________________

		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 changes her/his mood 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 changes her/his mood 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 corrects us quickly 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 get this teacher annoyed.	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 is 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 marks papers hard.	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

Teacher Use Only: Lea____ Und ____ Unc ___ Adm ____ HFr ___ SRe ____ Dis ___ Str ___

APPENDIX B **The Students' Motivation and Self-Efficacy in Science Questionnaire (SMASES)**

<u>Students' Motivation, Attitude and Self-Efficacy in Science</u>

Items 1 – 32 below consist of a number of statements about science and science lessons you might have in this class.

You will be asked what you think about these statements.

There are no 'right' or 'wrong' answers.

Your opinion is what is wanted. If you want to change your answer, cross it out and circle a new number. Make sure you answer **every** question.

For **each** statement, draw a circle around

5 if you **STRONGLY AGREE** with the statement
4 if you **AGREE** with the statement
3 if you **HAVE NO OPINION** on the statement
2 if you **DISAGREE** with the statement
1 if you **STRONGLY DISAGREE** with the statement

For example: Science lessons are fun

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
5	**4**	**3**	**2**	**1**

Please complete the following details below before commencing the questionnaire.

Student name: ________________________________

School: ________________________________

Grade: ________________________________

Teacher: ________________________________

A. SCIENCE LEARNING VALUE		Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
1.	I think that learning science is important because I use it in my daily life.	5	4	3	2	1
2.	I think that learning science is important because it stimulates my thinking.	5	4	3	2	1
3.	In science, I think that it is important to learn to solve problems.	5	4	3	2	1
4.	In science, I think it is important to participate in inquiry activities.	5	4	3	2	1
5.	It is important to have the opportunity to satisfy one's own curiosity when learning science.	5	4	3	2	1
B. PERFORMANCE GOAL		**Strongly Agree**	**Agree**	**No Opinion**	**Disagree**	**Strongly Disagree**
6.	I participate in science courses to get a good grade.	5	4	3	2	1
7.	I participate in science courses to perform better than other students.	5	4	3	2	1
8.	I participate in science courses so that other students think that I'm smart.	5	4	3	2	1
9.	I participate in science courses so that the teacher pays attention to me.	5	4	3	2	1
C. ACHIEVEMENT GOAL		**Strongly Agree**	**Agree**	**No Opinion**	**Disagree**	**Strongly Disagree**
10.	During a science course, I feel most fulfilled when I achieve a good score in a test.	5	4	3	2	1
11.	During a science course, I feel most fulfilled when I gain confidence with the content.	5	4	3	2	1
12.	During a science course, I feel most fulfilled when I am able to solve a difficult problem.	5	4	3	2	1
13.	During a science course, I feel most fulfilled when the teacher accepts my ideas.	5	4	3	2	1
14.	During a science course, I feel most fulfilled when other students accept my ideas.	5	4	3	2	1

D. ATTITUDE TOWARDS SCIENCE		Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
15.	I look forward to Science lessons.	5	4	3	2	1
16.	Science lessons are fun.	5	4	3	2	1
17.	I enjoy the activities we do in science.	5	4	3	2	1
18.	What we do in science are among the most interesting things we do at school.	5	4	3	2	1
19.	I want to find out more about the world in which we live.	5	4	3	2	1
20.	Finding out about new things is important.	5	4	3	2	1
21.	I enjoy science lessons in this class.	5	4	3	2	1
22.	I like talking to my friends about what we do in science.	5	4	3	2	1
23.	We should have more science lessons each week.	5	4	3	2	1
24.	I feel satisfied after a science lesson.	5	4	3	2	1
E. SELF-EFFICACY		**Strongly Agree**	**Agree**	**No Opinion**	**Disagree**	**Strongly Disagree**
25.	I find it easy to get good grades in this subject.	5	4	3	2	1
26.	I am good at this subject.	5	4	3	2	1
27.	My friends ask me for help in this subject.	5	4	3	2	1
28.	I find this subject easy.	5	4	3	2	1
29.	I perform better than most of my classmates in this subject.	5	4	3	2	1
30.	I have to work hard to pass this subject.	5	4	3	2	1
31.	I am an intelligent student.	5	4	3	2	1
32.	I help my friends with their homework in this subject.	5	4	3	2	1

APPENDIX C **Letter to Schools**

BRISBANE
March 14, 2004

Principal
XXX
BRISBANE

Dear X,

I am currently enrolled in the Doctor of Science Education program at Curtin University of Technology, Perth, Western Australia. My thesis topic is *Teacher Interpersonal Behaviour: Its Influence on Student Motivation, Self-Efficacy and Attitude Towards Science.*

I am writing to seek your permission to include the College Junior Science classes in my research. I envisage that all science students in years 8-10 would complete two questionnaires to assist in my quantitative research. At a later stage, I would like to interview a small number of students for the qualitative analysis section of my thesis. I do stress that the College, the students and the staff will not be identified in this research.

The questionnaires would take no longer than 30 minutes to complete in total and there would be minimal interruption to the school academic program on that day. Firstly, the Questionnaire on Teacher Interaction (QTI) will help to identify 'types' of teacher behaviour in the science classroom. The second questionnaire, *Students' Motivation, Attitude and Self-Efficacy in Science* (SMASES) examines how students respond to learning science and what type of teaching enhances their level of motivation, attitude and self-efficacy. I have included both questionnaires for your perusal. I believe that my research to be most valuable in identifying effective classroom science teaching and the types of interpersonal teacher behaviour that enhance a positive classroom environment. On x's recent visit to the College, she stated that teachers should be concerned with 'developing the students as reflective learners.' I see that student involvement in my research to be an avenue by which they can reflect on their own classroom climate. At the completion of my study, I will forward you an overview of my results.

I look forward to your support. Could you please advise me of your decision regarding my research at your earliest convenience. Ideally, I would like to administer the questionnaires before the end of Term 1.

Yours faithfully

Miss Catherine Reid

APPENDIX D Letter to Parents

August 25, 2004

Dear Parent(s),

My name is Catherine Reid. I teach Science, Mathematics, French and Religious Education in a private order-owned girls' college in Brisbane, QLD. I am a part-time Doctoral student at the Science and Mathematics Education Centre, Curtin University of Technology, Perth. The focus of my research entails examining teacher interpersonal classroom behaviour in science and its effect on student motivation, self-efficacy, attitude towards and enjoyment of science. The study will endeavour to identify teaching strategies and teacher interpersonal behaviours that enhance students' willingness to want to learn and enjoy science.

This letter is designed to seek your permission to allow your daughter to partake in the study. She would be asked to complete two questionnaires, during one of her science lessons this term, to aid my research. A few students maybe required to be interviewed at a later date in order to express their interpretation of their classroom environment. Please be assured that the data collected is confidential and is to be used in the construction of my thesis. The overall results will not identify students, staff or the schools involved in the research.

Could you please complete the form below and return it to your daughter's science teacher by the end of this week, if you intend to allow your daughter to participate in this valuable research.

Thank you in anticipation for your assistance and cooperation.

Catherine Reid

I have read the attached letter regarding the research being conducted by Catherine Reid in relation to Teacher Interpersonal Classroom Behaviour: Its Influence on Student Self-Efficacy, Motivation and Attitude to Science. I give permission for my daughter to complete the questionnaires and any interview related to her research. I am aware that the data collected is confidential.

Parent name & signature: ___________________________

Date: __________

Daughter's name: ________________________________

Year level & Science Class: ___________________________

APPENDIX E Interview Questions for Students

INTERVIEW QUESTIONS

1. Do you think your science classroom environment (atmosphere) is influenced by your teacher's interpersonal behaviour (the way in which he/she speaks and relates to the students)?

2. Do you think your teacher's interpersonal behaviour affects your attitude towards science?

3. Do you believe that your teacher's interpersonal behaviour with students affects your motivation towards learning science?

4. Do you believe that your teacher's interpersonal behaviour affects your self-efficacy (self-belief in your ability) in science?

5. What types of teaching strategies and classroom activities influence your attitude towards science?

6. What types of interpersonal behaviour does your teacher show that motivates you to want to learn science?

7. Does you teacher's interpersonal behaviour motivate you to want to achieve a good grade in science?

8. Do you believe that students work harder in science depending on who they have for their teacher?

9. Is your science classroom a pleasant place to learn?

10. Is your teacher encouraging of your efforts in the science classroom?