Science and Mathematics Education Centre

Teacher Interpersonal Behaviour in Gifted Students' Primary Science Classrooms and Effects on Achievement

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Declaration

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

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

Signature: .....

Date: 26/6/09

DEDICATION

This thesis is dedicated to my father, Lee Yum Long.

致

我老爸，李隆

ABSTRACT

There is a strong tradition in classroom environment research involving investigations of associations between students' outcomes (achievement and attitude) and the classroom learning environment. This study focuses on how the perception of Primary 5 (11-year-old) Gifted Education Programme (GEP) pupils on their science teacher could affect their cognitive achievement and attitude towards science. A sample of 279 students from 15 GEP classes from six (out of a possible nine) Singapore GEP primary schools participated in this study. The Questionnaire on Teacher Interaction (QTI) was employed to collect quantitative data. Qualitative data were also collected to complement the quantitative data. Research objectives in this study include determining the validity and reliability of the 48-item version QTI in primary science gifted classes and identifying the types of science teachers in the GEP in Singapore based on the Australian QTI-based typologies. The QTI covers eight scales of teacher behaviour. Generally, statistics showed that there is strong association between the Leadership scale and students' attitude towards science. A teacher perceived highly by student on the Leadership scale would be confident and assertive in class. A strong association between the Strict scale and students' cognitive achievement is also reported. In this study, no gender differences in the students' perception of their teachers has been found.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

The Gifted Education Programme (GEP) was first implemented in Singapore in 1984. It was initiated by the Ministry of Education (MOE) in line with its policy under the New Education System to allow each student to learn at his/her own pace. The Ministry of Education has a commitment to recognize, nurture and develop the potential of each student. This means that it must provide an education of quality and relevance which stimulates individual growth and helps students realise their full potential for the fulfilment of self and the betterment of society. Many changes have taken place in the 24 years that the programme has been running. It started with two schools and eventually expanded to nine Primary schools nationwide. In 2007, when the data were collected, there was a total of 498 Primary 5 (aged 10 -11) GEP students (336 boys and 162 girls) in Singapore. These students make up the top one percent of the cohort.

A careful look at the instructional practices currently used in the gifted classroom—and their inadequacies—could help us to learn how best to nurture the talents of the gifted. Science lessons are incorporated in the Primary school curriculum from Primary 3 (aged 9) onwards. By the time students are enrolled in GEP in Primary 5 (aged 11), they would already have two years of curriculum exposure to science; hence it was considered an appropriate level for selection for this study.

1.1.1 Primary Education in Singapore

The Primary education programme in Singapore consists of a 4-year foundation stage from Primary 1 to 4 and a 2-year orientation stage from Primary 5 to 6. Its overall aim is to give students a good grasp of English language, Mother Tongue and Mathematics. This is a compulsory 6-year course for all Singaporean children where school fees are not imposed. Parents only need to pay a standard miscellaneous fee.

At the end of Primary 3, the top 1% of the cohort will be streamed into the Gifted Education Programme (GEP) from Primary 4 and will be posted to selected schools which offer the GEP. At the end of Primary 6, students sit for a national examination – Primary School Leaving Examination (PSLE) where their performance is considered for admission into Secondary schools.

1.1.2 History and Milestones of Gifted Education Programme (GEP) in Singapore

As stated earlier, the Gifted Education Programme began in 1984. This section describes some significant events regarding the history of the development of this programme.

In 1981, the late Dr Tay Eng Soon, then Minister of State for Education, led a mission to study the gifted education programmes in other countries. This mission overseas strengthened the belief that there was a compelling need to start a programme for gifted children in Singapore. Such a programme for the intellectually gifted was not unique to Singapore. Countries such as the USA, China, Russia, and Israel also have developed programmes to nurture the intellectually gifted among their students.

In 1983, a concept paper was drawn up. It gave the rationale for and objectives of a programme for gifted children. The GEP would be for the intellectually gifted. The paper also described the proposed structure of such a programme and discussed the identification of teachers and the process of selection of students for the programme. What was proposed was an enrichment, not an accelerated, programme.

In May of that year, the Special Project Unit, now called the Gifted Education Branch, was formed. The team's main tasks were to select students and teachers for the GEP, train the teachers, prepare the new curriculum materials as well as implement the programme and monitor its progress. The team received training from a specialist in gifted education from the USA. A consultant was also attached to the programme.

Then in 1984, a pilot project was started in two primary schools, Raffles Girls' Primary School (RGPS) and Rosyth School (RS), and two secondary schools, Raffles Girls' Secondary School (RGSS) and Raffles Institution (RI).

1.1.3 Selecting Students

Students selected for the GEP are those with high intellectual ability and potential. The MOE conducts an annual screening test for all Primary 3 students in August each year. This test comprises two papers, English and Mathematics, which make up round 1 of the selection process, where the top 3,000 students will be shortlisted for the Selection test in round 2. Shortlisted candidates of the Screening test are then invited to sit the GEP Selection Test usually held in October each year. The selection of students to join the GEP at Primary 4 is based on their performance in all three papers in the GEP Selection Test. The three papers in the test are English Language, Mathematics and General Ability, a test of general reasoning ability specially set to select students for the GEP. It is not a standardised IQ test.

The GEP has places for the top one percent of the cohort. About 500 students are invited to take up these places depending on their performance in the three papers in the Selection Test as compared to the performance of the other students in the cohort, rather than on their achieving a certain score. Students eventually selected for the GEP are those with high intellectual ability and potential.

Having been selected the eligible and enrolled students join the GEP at Primary 4 in one of the nine Primary schools that offers this programme.

1.1.4 The GEP Curriculum

Trained subject teachers are specially deployed by the MOE to teach students in GEP in English, Mathematics, Science, Mother Tongue and Social Studies. The students' academic achievement and attitude towards learning are monitored closely throughout these three years in the GEP. Importance in cognitive, affective achievements and psychomotor development is equally emphasized in the curriculum. Other programmes such as the Music Elective Programme (MEP) and the Art

Elective Programme (AEP) cater to those talented in music and art, respectively, from Secondary 1 to Junior College 2.

Students in GEP also are required to participate in Co-Curriculum Activities (CCA) in areas of sports, uniform groups and /or clubs and societies. This is to promote an all-rounded education where their learning potential is maximised to the full. The GEP students sit school-based tests and assessments which are set specially for them. These test their ability in critical and creative thinking rather than just knowledge of content alone. There is also continual assessment based on the students' daily work and assignments. GEP students are also prepared for the same national examinations that the students in the mainstream take. At the end of Primary 6, GEP students sit the Primary School Leaving Examination just like students in the regular stream.

1.2 THEORETICAL FRAMEWORK

While the schools continue to prepare students for future challenges, psychosocial dimensions of the school climate and classroom learning environment form the cornerstone of the overall quality of teaching and learning in schools. At the classroom level, teachers' behaviours while interacting with students have been found to influence students' like or dislike for learning a subject (Goh, Young, & Fraser, 1995; Wubbels & Levy, 1993)

The strongest tradition in past classroom environment research has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classrooms. Approximately 40 studies tabulated by Fraser (1994) show that associations between outcome measures and classroom environment perceptions have been replicated for a variety of cognitive and affective outcome measures, a variety of classroom environment instruments, and a variety of samples across grade levels and countries.

The history of the first three decades of learning environments research shows a strong emphasis on the use of a variety of validated and robust questionnaires that assess students’ perceptions of their classroom learning environment.

There is a wide variety of these economical and valid questionnaires that have been used for the past 30 years to assess students' perceptions of the learning environment (Fraser, 1998a; Fraser, 2002). Historically important and contemporary instruments include 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); *Questionnaire on Teacher Interaction* (QTI); *Science Laboratory Environment Inventory* (SLEI); *Constructivist Learning Environment Survey* (CLES); and the *What Is Happening In This Class* (WIHIC) questionnaire.

Additionally, qualitative methods for assessing the learning environment have been combined with quantitative methods to provide additional validity and plausible explanations for findings (Fraser & Tobin, 1991; Tobin, Kahle & Fraser, 1990; Tobin & Fraser, 1998)

1.3 OBJECTIVES OF THIS STUDY

A main purpose of this study was to provide important insights into the gifted science classroom learning environments in Singapore Primary schools. The research focus was to study specifically how teacher-student interaction is related to Primary 5 gifted students' cognitive achievement and attitudes towards science.

The research objectives are as follows:

1. to determine the validity and reliability of the 48-item version of the Questionnaire on Teacher Interaction (QTI) in the primary science gifted classes;

2. to determine the validity and reliability of three Attitude Scales adapted from the *Test of Science Related Attitudes* (TOSRA) (Fraser, 1981);

3. to investigate gifted student perceptions of teacher interpersonal behaviour in the science classroom;

4. to investigate any associations between gifted student perceptions of teacher interpersonal behaviour and student attitudinal and cognitive outcomes;

5. to compare and identify differences in gifted student and teacher perceptions;

6. to identify the types of science teachers in the GEP in Singapore based on the Australian QTI-based typologies; and

7. to compare gender-related differences in perceptions of gifted students in the science classes.

These objectives give rise to the following research questions:

1. Is the QTI a valid and reliable questionnaire in primary science gifted classrooms in Singapore?

2. Are the three Attitude scales adapted from the TOSRA, namely, Attitude to Science Inquiry, Adoption of Science Attitude and Enjoyment of Science Lessons, valid and reliable scales for use in primary science gifted classrooms in Singapore?

3. What are gifted students' perceptions of their science teachers' behaviours in the classroom?

4. Are there any associations between gifted student perceptions of teacher interpersonal behaviour and student attitudinal and cognitive outcomes?

5. Are there any differences in gifted student and teacher perceptions?

6. What are the types of science teachers in the GEP in Singapore, based on the Australian QTI-based typologies?

7. Are there any gender-related differences in perceptions of gifted students in their science classes?

1.4 SIGNIFICANCE OF PRESENT STUDY

Singapore is a small nation with only human resources to rely on for its progress and prosperity. It is to the advantage of the nation that the gifted are helped and nurtured. The GEP monitors the cognitive and affective progress and achievements of the high-ability students very closely. A lot of resources have been channelled to identify and develop talents in this island country.

This study is significant for several reasons. First, this is the first major study in the world of the science classroom learning environment conducted among primary gifted students. It will provide valuable information about GEP. Secondly, the QTI has never been administered in Singapore for primary school science students in the gifted stream. This will be the first study on gifted students in a primary science context. Furthermore, gifted students' cognitive and attitudinal outcomes are always constantly being monitored by MOE and other stakeholders of education, thus any association between their perceptions and learning outcomes is of great value to the educators and researchers of gifted education. Finally, the research method used in the study is focused on gaining detailed qualitative data about a small number of students but against a background of more general quantitative information from surveys of a larger group.

1.5 OVERVIEW OF METHODOLOGY

In view of the total population of Primary 5 gifted students in Singapore, 279 students from six primary schools participated in this study, out of 498 from all nine Singapore schools offering GEP.

This sample size represents a significant fraction of the entire gifted population, though Ministry of Education (MOE) and Gifted Education Branch (GEB) did not grant permission to obtain data from all nine schools.

Thus, the sample consists of 279 primary 5 students from 15 classrooms in six primary schools offering the GEP.

Quantitative data were collected in the first semester of the academic year 2007. First, students' responses to *Questionnaire on Teacher Interaction* (QTI) and scales of *Attitude to Science Inquiry, Adoption of Science Attitude* and *Enjoyment of Science Lessons* adapted from TOSRA were collected, followed by small group interviews with 22 student volunteers from participating schools. Permission from these students' parents was sought. Each group interview lasted about 40 minutes to gain more insights into the science classroom environment. The data were recorded and later transcribed to complement the quantitative data obtained. Classroom observations were conducted with three classes to further enhance the qualitative data.

The SPSS software package provided statistics for QTI and adapted TOSRA scales. The reliability, discriminant validity and ability to differentiate between classrooms were completed using the individual student as the unit of analysis. Differences between male and female students' perception toward their science teachers as well as differences between teacher and student perceptions and differences between teacher self and ideal perceptions were investigated. The relationships between the scales of Teacher behaviour and attitudinal and cognitive outcomes were examined using the Pearson's correlation procedure. Regression analysis was used to examine the contribution of teacher support to each attitude and cognitive variable. By utilising information from quantitative and qualitative methods for triangulation, the validity of research results could be ensured.

1.6 LIMITATIONS OF THE STUDY

Students from some schools were hesitant to give frank feedback about their teachers' behaviour in classes, especially on what they do not like about the teacher, as students tend to be more reserved in the Asian classrooms. Even though only some students' comments provided valuable insights and information about the study, these comments were taken as representative of the population from the school.

The researcher is also a full-time GEP science teacher teaching in one of the GEP schools; hence it was difficult to take time off to interview students from all six schools during curriculum hours. Scheduling interviews and classroom observations

was very much constrained by the researcher's own class time-table, despite exchanges of periods with school colleagues. At the same time, only three teachers from the six participating schools agreed to classroom observation. Teachers in GEP had to cover the prescribed syllabus and were not keen to use their lesson time to administer questionnaires and arrange interviews.

Another limitation could arise because the presence of observers could perhaps alter what generally occurs in the classroom.

1.7 OVERVIEW OF THE THESIS

This thesis consists of seven chapters presenting the design, development and findings of the study. This first chapter has introduced and summarised the purpose of this study and outlines the objectives, provides a brief overview of the limitations, and discusses the significance of the present study.

Chapter 2 presents a review of literature pertinent to this study. In this chapter, literature describing learning environment research, teacher-student research and students' attitude are examined. Review of literature from studies using the Questionnaire of Teacher Interaction and interpersonal behaviour research are also presented.

Chapter 3 defines the research methodology used to address the research questions. Elaboration on the research method is included, as well as research questions used to derive research objectives, historical background of the QTI and the TOSRA used in this study, data collection, the samples, and the measures used to the analyse qualitative and quantitative data.

Chapter 4 describes the validation of the QTI in Primary science gifted classrooms.
Chapter 5 gives the results of analysis performed on the quantitative data to address the research questions given in Chapter 4.

Chapter 6 presents data from qualitative measures. These include associations between attitudes and cognitive achievements with teacher-student interactions and

the science classroom (GEP) learning environment in Singapore. From this qualitative data comprising students' interview and classroom observations, a comprehensive view of classroom environments and teacher behaviours is obtained.

Chapter 7 summarises all the materials presented in this study, including results pertinent to the research questions formulated and some significant conclusions arrived at. Discussions on the limitations of this study and suggestions of any implications that the results may have on the teaching practice are raised. The relationships between the qualitative and quantitative findings are highlighted, addressing associations between students' perceptions of the classroom learning environment and their attitudinal and achievement outcomes. Suggestions for further research based on the findings of this study are outlined.

Following the references are several appendices consisting of a full set of questionnaires as used in the study and the interview questions, the schedule, and letters of consent.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Recent reviews over the last three decades (Fraser, 1986, 1994; Fraser & Walberg, 1991) show that science education researchers are relentlessly working to understand and improve science education.

As part of this endeavour, over the past 30 years a number of instruments have been developed to measure classroom environments (Fraser, 1991, 1994; Shavelson & Seidel, 2006). Each of these instruments is valuable in its own right, has been used extensively in research and has demonstrated reliability in comprehensive field trials. Collectively, however, there is some overlap in the dimensions which they measure. In their preface to a special edition of the *Learning Environments Research: An International Journal*, Shavelson and Seidel (2006, p. 195) make three related propositions about teaching and learning:

1. … in order to understand the effects of educational programs (e.g. inquiry science teaching) on student outcomes, we need to account for the intervening instructional processes;
2. we need to observe and measure these instructional processed to understand them, and
3. We suspect that there are almost as many instruments for measuring learning environments as there are researchers doing this work.

The classroom instruments provide a means of monitoring, evaluating and improving science teaching and curriculum. A key to improving students' achievement and attitudes is to create learning environments which emphasize those characteristics which have been found to be linked empirically to student outcomes.

It is noteworthy that the instruments that have been used in studies of learning environments are often related to the theoretical framework for human environments proposed by Moos (1974) described in section 2.3.

2.2 CONCEPTUAL FRAMEWORK FOR RESEARCH ON LEARNING ENVIRONMENT

The history of learning environments research has its roots in the social sciences. Lewin (1936) proposed the formula, $B = f(P, E)$ in which Behaviour (*B*) is a function of both the Person (*P*) and the Environment (*E*). Murray (1938) extended Lewin's ideas and distinguished between *beta* press (a description of the environment as perceived by people themselves in an environment) and *alpha* press (a description of the environment as observed by a detached observer). There are many advantages in considering beta press, particularly in schools and classrooms, because an outside observer can miss important events and interactions. Murray (1938) applied Lewin's concepts of alpha and beta press to his needs–press model in which needs refers to an individual's motivation to achieve goals, while press describes how the environment either helps or hinders a person to meet their goals.

Stern, Stein, and Bloom, (1956) built on Murray's discrimination between alpha press and beta press. They suggested that beta press could further be discriminated by the individual view and experience of the environment that each student, for example, has of the learning environment versus the shared view that the students have as a group of participants in the learning environment. They used *private beta* press to represent the idiosyncratic view a student may have of the classroom environment and consensual beta press for the shared view of the students' perceptions. This study utilizes the student *consensual beta* press perspective for the data collected through survey and observation methods and *private beta* press perspective for the interviews conducted with the students. Brophy and Good (1986) further indicated that using students' and teachers' perceptions to study the educational environments, as said above, contrasted with an external observer's direct observation and systematic coding of classroom communication and events.

Rickards (1998) suggested that although Murray's needs-press model has been utilized and extended to report on high inference measurement in educational learning environments (Pace & Stern, 1958), outside observers rely on observations that are based on external experiences of the learning environment.

2.3 DEVELOPMENT OF LEARNING ENVIRONMENT INSTRUMENTS

In this section, many of the instruments that have been used to assess the quality and nature of the classroom learning environment over the last three decades are described. Moos' (1974) work has influenced the development and application of many instruments used to assess the qualities of the classroom learning environment from students' perspectives. The three basic dimension types conceptualized by Moos are Relationship Dimension, Personal Development Dimension and System Maintenance and System Change Dimension. The Relationship Dimension is defined as the nature and intensity of personal relationships within the environment and assesses the extent to which people are involved in the environment and support and help each other. The Personal Development Dimension assesses personal growth and self-enhancement. The System Maintenance and System Change Dimension involves the extent to which the environment is orderly, clear in expectations, maintains controls, and is responsive to change.

As each of the scales of all the instruments mentioned in this section can be categorized into one of the dimensions of Moos' scheme for classifying human environments, there is some commonality in the underlying conceptual frameworks for assessment of classroom environment.

Examples of classroom environment instruments are:

- Learning Environment Inventory (LEI)
- My Class Inventory (MCI)
- Classroom Environment Scale (CES)
- The College and University Classroom Environment Inventory (CUCEI)
- Individualised Classroom Environment Questionnaire (ICEQ)
- Science Laboratory Environment Inventory (SLEI)

- Constructivist Learning Environment Survey (CLES)
- What Is Happening In this Class? (WIHIC)
- Students' Perception of Assessment Questionnaire (SPAQ)

2.3.1 Learning Environment Inventory (LEI)

Walberg and his associates developed the *Learning Environment Invent*ory (LEI) to measure interpersonal relationships among pupils in the late 1960s in conjunction with evaluation and research related to Harvard Project Physics (Fraser, Anderson, & Walberg, 1982; Walberg and Anderson, 1968). The LEI was evolved from the 18-scale *Classroom Climate Questionnaire* developed by Walberg (1968). This final version of LEI has seven items per scale with a total of 105 items. The items are scored on a four-point Likert scale (Likert, 1932) with some items scored in reversed direction. A typical item in the Cohesiveness scale is 'All students know each other very well' and in the Speed scale is 'The pace of the class is rushed'. The LEI utilizes 15 dimensions of the classroom climate, which had been identified as good predictors of learning and were relevant to social psychological theory (Fraser & Walberg, 1991).

2.3.2 My Class Inventory (MCI)

The *My Class Inventory* (MCI) is a simplified form of the LEI with 38 items (Fisher & Fraser, 1981; Fraser, Anderson, & Walberg, 1982; Fraser & O'Brien, 1985), modified for use to improve comprehension with 8-12 year- old children. Although the MCI was developed originally for use at the primary school level, it also has been found useful with students in the junior high school, especially those with limited reading skills in English (Majeed, Fraser, & Aldrridge, 2001). The MCI differs from the LEI in four important ways. First, the MCI contains only five of the LEI's original 15 scales, in order to reduce fatigue among younger children. Second, item wording was simplified to enhance readability. Third, the LEI's four-point response format has been reduced to a two-point (Yes-No) response format. Fourth, students answer on the questionnaire itself instead of on a separate response sheet to avoid errors in transferring responses from one place to another. The final form of the MCI contains 38 items altogether, although Fraser and O'Brien (1985) have developed a

short 25-item version. Goh, Young, and Fraser (1995) have also successfully used a three-point response format (Seldom, Sometimes and Most of the Time) with a modified version of the MCI including a Task Orientation scale.

2.3.3 Classroom Environment Scale (CES)

The *Classroom Environment Scale* (CES) is a questionnaire used frequently in current research, and was developed by Rudolf Moos at Stanford University (Fisher & Fraser, 1983; Moos, 1979; Moos & Trickett, 1987). The initial development of CES was based on Moos' (1979) three basic categories for describing human environments, and eventually evolved from a comprehensive program of research involving perceptual measures of a variety of human environments including psychiatric hospital wards, prisons, university residences, military companies and work place environments. The final published version contains nine scales with ten items of True-False response format in each scale. All the scales are scored on a True-False response list with about half the items being reversed. Published materials associated with the CES include a test manual, a questionnaire, an answer sheet and a transparent hand-scoring key. The instrument evaluates the effects of course content, teaching methods, teacher personality, class composition and characteristics of the overall classroom environment. The CES can also be used both in the aggregate to evaluate the classroom itself, as well as with individuals to reveal how a student views the classroom and his or her place in it.

2.3.4 The College and University Classroom Environment Inventory (CUCEI)

The *College and University Classroom Environment Inventory*, (CUCEI), was specially developed by Fraser, Treagust, Williamson and Tobin, (1987) to assess perceptions of the psychosocial environment in university and college classrooms. Originally, the CUCEI was developed for use with small groups of about 30 students in seminars and tutorials in higher education classrooms (Fraser & Treagust, 1986; Fraser, Treagust, & Dennis, 1986). The final form of the CUCEI contains seven scales: Personalization, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation, and Individualization. Each scale comprises seven items, making a total of 49 items in all and each item has four responses and the score

direction is reversed for approximately half of the items. As with some other questionnaires, the CUCEI has been adapted to form instruments that are specific to particular studies. One example is the *Secondary Colleges Classroom Environment Inventory* (SCCEI) (Kent & Fisher, 1997) which was adapted from both the LEI and CUCEI.

2.3.5 Individualised Classroom Environment Questionnaire (ICEQ)

The *Individualised Classroom Environment Questionnaire* (ICEQ) was developed by Rentoul and Fraser (1979) to assess the dimensions, which distinguish individualised classrooms, from conventional ones. The initial development of the ICEQ was guided by the literature on individualised, open and inquiry-based education; extensive interviewing of teachers and secondary school students and reactions to draft versions sought from selected experts, teachers and junior high school students (Rentoul & Fraser, 1979). The original version of the ICEQ had five scales with fifteen items per scale. The final version was reduced to ten items in each scale giving a total of fifty items. Each item is responded to on a five point Likert-type response scale, and the scoring direction is reversed for some items.

2.3.6 Science Laboratory Environment Inventory (SLEI)

Laboratory settings play a vital role in science education, and this led to the development of an instrument, the *Science Laboratory Environment Inventory* (SLEI), specifically suited to assessing the environment of science laboratory classes at the senior high school and higher education levels (Fraser, Giddings, & McRobbie, 1991). The SLEI was developed to assess students' perceptions on learning environments in the laboratory classes (Fraser, McRobbie, Giddings, 1993). It has five scales of seven items each. Responses are scored on a five point Likert-type scale and approximately half of the items are reversed. The SLEI was field tested and validated simultaneously with a sample of 5,447 students in 269 classes in six different countries (USA, Canada, England, Israel, Australia and Nigeria) (Fraser, 1998a) and cross-validated with 1,594 Australian students in 92 classes (Fraser & McRobbie, 1995), 489 senior high school biology students in Australia (Fisher, Henderson, & Fraser, 1997) and 1,592 Grade 10 chemistry students in Singapore

(Wong & Fraser, 1995). This instrument is appropriate for the secondary and tertiary education which contains 35 items and five scales which are Student Cohesiveness, Open-Endness, Integration, Rule Clarity and Material Environment. Furthermore, this instrument is designed with economical cost which is only one page and easy for teacher to hand score. The SLEI instrument used a class and personal form for the first time to compare students' personal views with how they think the class perceives the environment. The personal version of students will give "meaningful and sensitive investigations of the environments existing within a class for different subgroups of students" (Fraser, Giddings, & McRobbie, 1992). Students may also respond to the actual and the preferred learning environments in their laboratory. The results could be different or similar, but the teacher could have valuable information of their students' perceptions on the actual and the preferred learning environment.

2.3.7 Constructivist Learning Environment Survey (CLES)

The *Constructivist Learning Environment Survey* (CLES) (Taylor, Fraser, & Fisher, 1997) is designed to assist researchers and teachers assess the degree to which a particular classroom's environment is consistent with constructivist learning. The initial four criteria guiding the development of CLES (Taylor, Fraser, & Fisher, 1997) were that the CLES had to be consistent with current literature, have a personalised response format, be economical to use and of significant value to teachers, researchers and students for whom it was intended. The original version of the CLES had 58 items with four scales that ranged from nine to twenty items. After further validation the CLES was reduced to five scales having six items each giving a total of 30. Items of the same scale of the CLES were grouped together under a simple scale name to provide a contextual cue for respondents (Taylor, Fraser, & White, 1994). The CLES is able to assist researchers and teachers to assess the degree to which a particular classroom's environment is consistent with a constructivist approach, and may assist teachers to possibly reshape their teaching practice.

2.3.8 What Is Happening In this Classroom (WIHIC)

The *What is Happening In this Classroom* (WIHIC) questionnaire was developed by Fraser, Fisher, and McRobbie (1996) by combining modified versions of the most

salient scales from a wide range of existing questionnaires with additional scales that accommodate comtemporary educational concerns (e.g. equity and constructivism). The WIHIC measures a wide range of dimensions which are important to the present situation in classrooms. It includes relevant dimensions from past questionnaires and combines these with dimensions that measure aspects of constructivism and other emphases relevant to the environment of contemporary classrooms (Fraser, Fisher, & McRobbie , 1996). The final form of the WIHIC contains seven scales with eight items in each scale. It can be used to measure students' perceptions from a class and personal viewpoint. The responses are recorded on a five point Likert-type scale. The factor structure of the WIHIC has been established in many countries (Aldridge , Fraser, & Huang, 1999; Fraser, Fisher, & McRobbie, 1996), Singapore (Chionh & Fraser, 1998), Brunei (Riah & Fraser, 1998a), and Taiwan (Aldridge & Fraser, 2000).

2.3.9 Students' Perception of Assessment Questionnaire (SPAQ)

The *Students' Perceptions of Assessment Questionnaire* (SPAQ) is the result of instrument development and validation procedures conducted in Essex, England (Dorman & Knightley, 2005) and Australia (Fisher, Waldrip, & Dorman, 2005). The SPAQ contains 30 items assigned to internally consistent scales, namely, Congruence with Planned Learning, Authenticity, Student Consultation, Transparency and Diversity. Responses to the SPAQ items are recorded on a four point Likert-type format of Almost Never, Sometimes, Often, and Almost Always. It can be used to assess secondary students' perceptions of assessment.

The *Questionnaire on Teacher Interaction* (QTI) is described later in Section 2.5 because it is selected for this study and hence described in greater detail.

Table 2.1 gives an overview of the seven classroom learning environment questionnaires described in section 2.3 and their categories according to Moos' scheme for classifying human environments.

Table 2.1

Overview of Scales of Seven Classroom Environment Questionnaires

Instrument	Level	Items per scale	Scales Classified According to Moos' Scheme		
			Relationship dimensions	Personal Development Dimensions	System and Change
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisation Democracy
My Class Inventory (MCI)	Elementary	6-9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalisation Involvement Cohesiveness Satisfaction	Task orientation	Innovation Individualisation
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task orientation Competition	Order and organization Rule clarity Teacher control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
Constructivist Learning Environment (CLES)	Secondary	7	Personal relevance Uncertainty	Critical voice Shared control	Student negotiation
What is Happening In this Classroom (WIHIC)	Secondary	8	Student cohesiveness Teacher support Involvement	Investigation Task orientation Cooperation	Equity

(Source: developed from Fraser, 1998b)

2.4 STUDY OF TEACHER-STUDENT INTERACTION

In the Netherlands, research with the Questionnaire on Teacher Interaction (QTI) has revealed statistically significant relationships between teacher-student interaction and student outcomes (Wubbels, Brekelmans, & Hooymayers, 1991). Earlier studies also showed that students whose teachers were directive (i.e., those who provided a well-structured and task-orientated learning environment) and tolerant/authoritative (i.e., those who provided a pleasant, well-structured environment and who had a good

relationship with students) showed the greatest cognitive and affective gains. The lowest student gains were associated with teachers who were uncertain/aggressive (i.e., those who offered an aggressive kind of disorder) and uncertain/tolerant (Quek, Wong, & Fraser, 2005b). The QTI rose rapidly as a popular teacher interpersonal behaviour research instrument and has been widely validated in the USA, Australia and Asia in the past decade. In a short span of 14 years, this particular instrument has evolved from the original Dutch version to the USA English version, Australian version and also was the Malay version administered in Brunei.

So far, the QTI had also been administered in Asian countries such as Singapore, Korea, Brunei, Indonesia and India, ranging from primary to University level, and in both mathematics to science classrooms. The reliability and validity of each version have been statistically confirmed. Recently, research using the QTI has been conducted in various academic subjects such as mathematics (Goh & Fraser, 1996; 1998), biology (Fisher, Henderson, & Fraser, 1995), chemistry (Fisher, Goh, Wong, & Rickards, 1997), vocational education (Henderson & Fraser, 2008) English as a foreign language (Wei, den Brok, & Zhou, 2009) and project work (Quek, Wong, Divaharan, Liu, Peer, & Williams, 2007) at the primary, secondary and pre-university levels.

The scope of this review confines itself to the usage of QTI in science classroom environments. Although it first started as a secondary school level questionnaire, it has since been adapted across levels and found to be useful and applicable in primary and high schools as well. The successful validation of QTI in so many countries at various levels is indeed a noteworthy point in learning environments research. The following sections describes the theoretical framework on which the QTI is based and its consequent development.

2.4.1 Historical Background

In 1957, Leary developed a model that allows graphical representation of interpersonal behaviours along two dimensions: influence and proximity. It basically states that people communicate according to two dimensions – Dominance-Submission (who is controlling the communication) and Cooperation-Opposition

(how much cooperation there is between the people who are communicating). The influence dimension (Dominance, D – Submission, S) is used to measure the degree of dominance or control over communication process, and the proximity dimension (Cooperation, C – Opposition, O) is used to measure the degree of affinity or cooperation felt by those involved in the communication process.

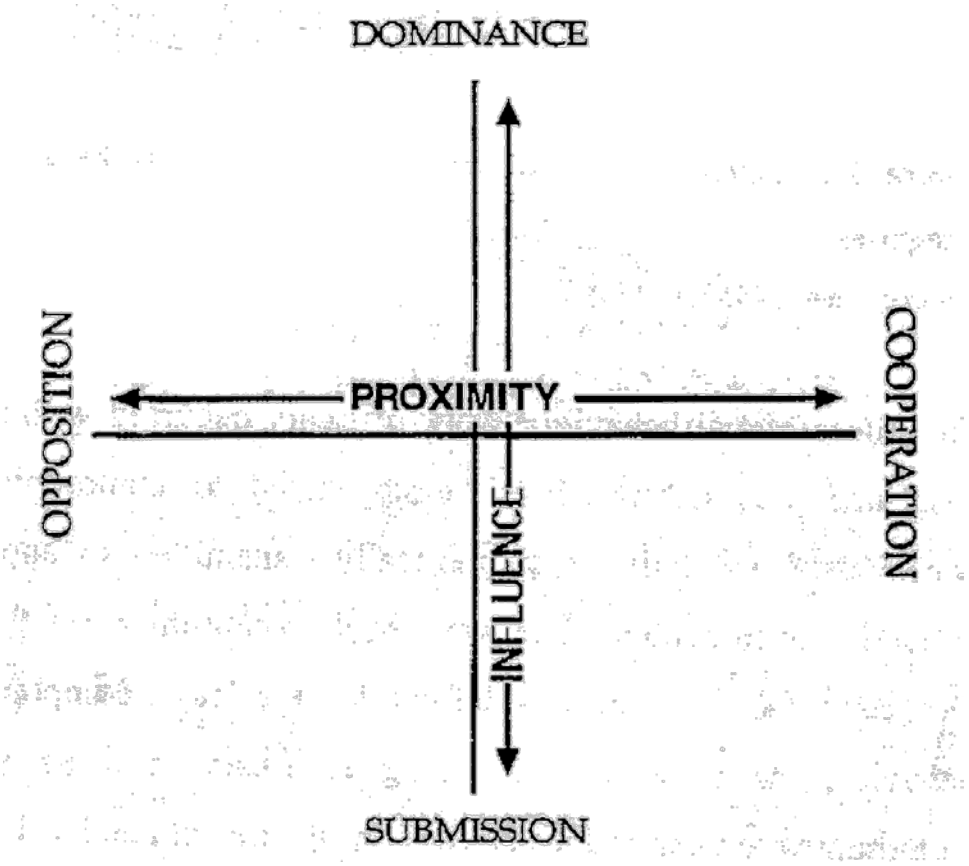


Figure 2.1. The two-dimensional coordinate system of the Leary model.
(Source: Wubbels, Creton, & Hooymayers, 1993, p.15)

Many years later in education research, developments took place in The Netherlands where the research focus was emphasised on the interactions between the teachers and students (Wubbels and Brekelmans, 1998; Wubbels and Levy, 1993). Developments unfolded as Wubbels, Creton and Holvast (1988) investigated teacher behaviour in classrooms from a systems perspective, adapting a theory on communication processes developed by Watzlawick, Beavin and Jackson (1967). Within the systems perspective on communications, it is assumed that the behaviours of participants influence each other mutually. The behaviour of the teacher is

influenced by the behaviour of the students which in turn influences student behaviour. Hence a circular communication process is developed, where a cycle of behaviours ensue. This constant exchange takes place between the teacher and students consciously and subconsciously.

Using the systems perspective as a basis, Wubbels, Creton and Hooymayers (1985) were inspired to develop a model to map interpersonal teacher behaviour extrapolated from the work of Leary (1957). When applied to teachers, Leary's proximity and influence dimensions were adapted to be represented in a coordinate system divided into eight equal sections as shown in Figure 2.2. Each sector of the diagram was named to represent the following typical behaviours of the teacher: Leadership (DC), Helping /Friendly (CD), Understanding (CS), Student Responsibility / Freedom (SC), Uncertain (SO), Dissatisfied (OS), Admonishing (OD) and Strict (DO).

Adjacent scale sectors in the model tend to resemble each other more closely, and sectors become increasingly more different until they are diametrically opposite each other as in the case of Admonishing (OD) and Understanding (CS) scales. (Fisher, Fraser & Wubbels, 1993)

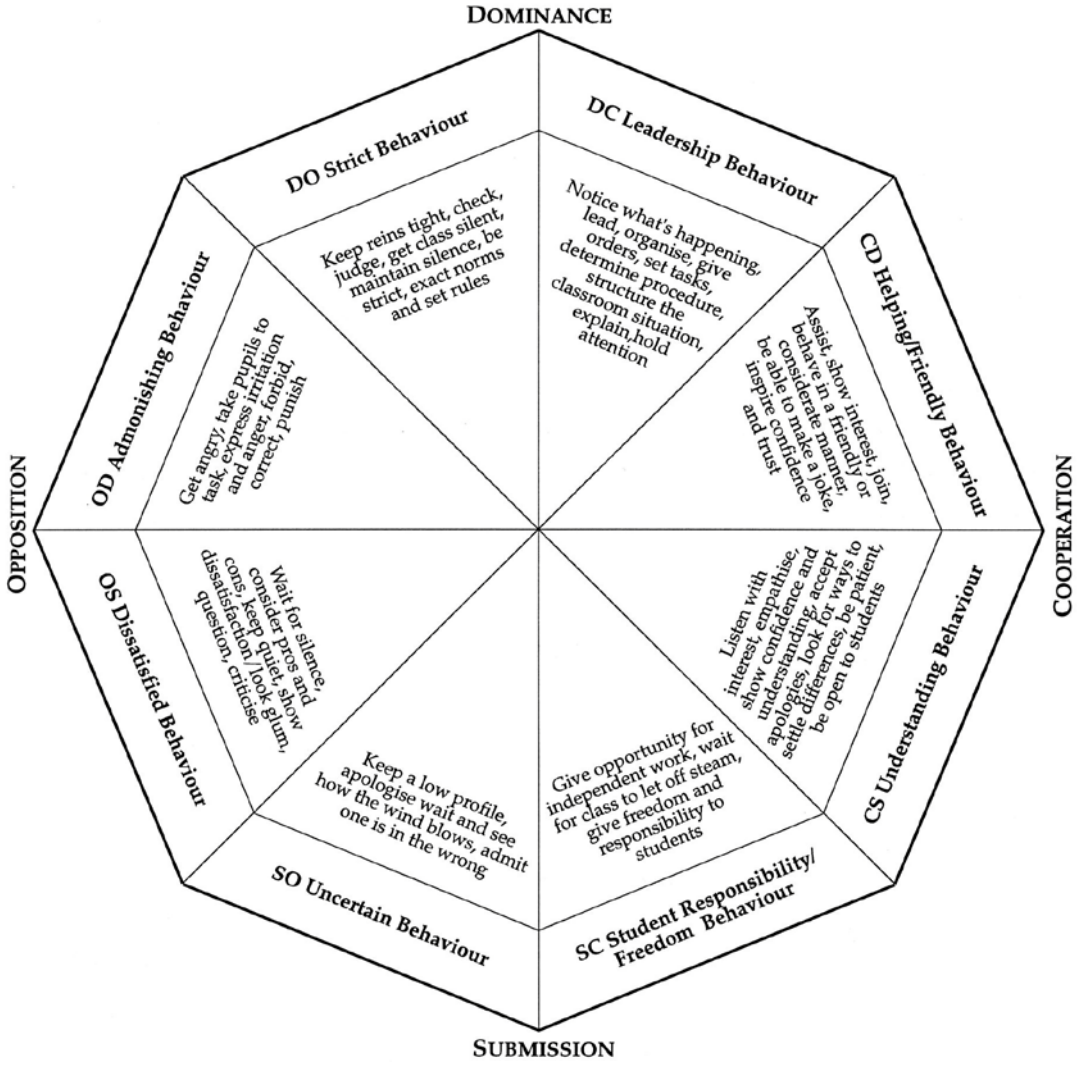


Figure 2.2. The model for interpersonal teacher behaviour. (Wubbels & Levy, 1991, p. 3)

During tabulation, the scores for each item within the same sector were added to obtain a total scale score. The higher the scale score the more a teacher showed behaviours from that sector. Scale scores could be obtained for an individual student, or could be combined to form the mean of all students in a class. The higher the scale score, the more prominent was the behaviour. These values can then be plotted on sector profile diagrams to reveal diagrammatically the degree to which students perceive each behaviour exhibited by the teacher.

2.4.2 The Ongoing Development of the QTI

The original Dutch version of the QTI consisted of 77 items in the eight scales (Wubbels, Cretons, & Hooymayers, 1985). In 1991, there was development for use in the USA an English-language version comprising of a total of 64 items, with eight items for each of the eight scales (Wubbels & Levy, 1991). This 64-item USA version of the QTI was used with 1,606 students and 66 teachers, Wubbels and Levy reported acceptable internal consistency reliabilities for the QTI scales ranging from 0.76 to 0.84 for student responses and 0.74 to 0.84 for teacher responses. The USA version was confirmed as a valid and reliable instrument for students and teachers in the USA. This English version was subsequently scrutinised and simplified when used in Australian secondary schools. A 48-item of the Australian version (Fisher, Henderson, & Fraser, 1995), using a five-point response scale, emerged. It was first used in senior biology classes with a sample of 489 students in 28 biology classes.

These studies confirmed the validity and reliability of the Australian English version of the QTI and its potential usefulness verified by studies conducted in various contexts in Australia (Rickards & Fisher, 1998).

Now the Australian version of the QTI has been used in many studies involving science classes across Australia (Fisher, Fraser & Wubbels, 1993; Fisher, Henderson & Fraser, 1995; Fisher, Rickards & Fraser, 1996; Fisher & Waldrip, 1999).

Table 2.2 shows examples of sample items for each scale from the QTI.

Table 2.2

Description of Scales and Sample Items for Each Scale of the QTI

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

(Source: adapted from Wubbels, 1993)

2.4.3 Application and Validation of QTI in Numerous Classroom Environments in Asia

The QTI has been used in numerous large-scale studies in Asia. Goh pioneered the use of the QTI in a simplified form (with a three-point Likert scale response format) in Singapore with a sample of 1,512 primary Mathematics students in 39 classes in 13 schools. (Goh & Fraser, 1998). This was the first time a primary version of the QTI was developed, validated and used in research applications. The study cross-validated the QTI for use in a new country and found it to be useful in several research applications.

Also, further support for the validity and usefulness of the QTI in Singapore was provided by Quek, Fraser and Wong's (2001) study among 497 gifted and non-gifted Chemistry students and by Fisher, Goh, Wong and Rickards' (1997) study involving 20 secondary Science classes.

Scott and Fisher (2001) translated the QTI into Standard Malay and cross-validated it with 3,104 primary school students in 136 classes in Brunei Darussalam. That was the first investigation using the QTI to determine primary students' perceptions of their teachers' classroom behaviour in Brunei. An English version of the QTI was also cross-validated for secondary schools in Brunei Darussalam for samples of 1,188 science students (Khine & Fisher 2002) and 644 upper secondary chemistry students (Riah & Fraser, 1998a).

In Korea, Kim, Fisher and Fraser (2000) validated a Korean-language version of the QTI among 543 Grade 8 students in 12 schools. In that study, boys generally reported more favourable attitudes towards the classroom, teacher behaviour and science classes. Lee and Fraser (2002) provided further cross-validation information for the QTI using a sample of 440 Grade 10 and 11 science students.

In Indonesia, Soerjaningsih, Fraser and Aldridge (2001) translated the QTI into the Indonesian language and cross-validated it with a sample of 422 university students in 12 research methods classes. It was the first time QTI was used in Indonesia and also represented one of only a few studies worldwide that focused on the learning environment at the university level where the study examined the relationships between students' cognitive and affective outcomes and the quality of teacher-student interactions.

The QTI was also administered and validated with 1,021 Grades 9 and 10 students in 31 Science classes in Jammu, India (Koul & Fisher, 2005), where teacher behaviour and its associations were studied.

Levy, Creton & Wubbels (1993) analysed data from studies in The Netherlands, the USA and Australia involving students being asked to use the QTI to rate their best and worst teachers. Students rated their best teachers as being strong leaders and as

friendly and understanding. The characteristics of the worst teachers were that they were more admonishing and dissatisfied.

From a 1995 Australian study, the conclusion was drawn that if biology teachers want to promote favourable student attitudes in their class and towards laboratory work, they should ensure the presence of "leadership, helping/friendly and understanding" interpersonal behaviours. (Fisher, Henderson & Fraser, 1995).

In Fisher, Waldrip and Churach's (2003) study of Australian science classes, it was found that better primary science teachers could be identified through the perceptions of their students on the scales of the QTI. The better teachers were those whose students' perceptions were more than one standard deviation above the mean on the scales of Leadership, Helping/Friendly and Understanding, and about one standard deviation below the mean on the Dissatisfied and Admonishing scales. Subsequent interviews were carried out to qualify the construct validity of the QTI in the above identification.

An adaptation of Goh's (1994) work was used in the Brunei study of 3,104 upper primary science students (Scott & Fisher 2004), where a Malay version of the primary QTI was created and validated. Comparing Asian studies of teacher interpersonal behaviours using the primary QTI instrument in Brunei and Singapore, very prominent similarities were observed, with Leadership being the scale with the highest score. Singapore and Brunei have similar education systems, hence it is no surprise that similar results were obtained.

In addition, a very recent study of Korean High school science classrooms (Lee, Fraser, & Fisher, 2003) reflected that science teachers in Korean high schools are directive, controlling and not supportive of students' self-activities.

There were also findings which concluded that Australian teachers were perceived as giving more responsibility and freedom to their students than was the case for the Singapore sample, whereas teachers in Singapore were perceived as being stricter that their Australian counterparts, in a cross-national study of secondary Science classes in both countries (Fisher, Goh, Wong, & Rickards, 1997). These differences

are not surprising given the different cultural backgrounds and education systems in the two countries.

At the same time, females perceived their teachers in a more positive way than males and students from Asian background tended to perceive their teachers more positively than those from the other cultural groups in the study of Fisher and Rickards (1997). Comparing past learning environments studies, scales for students' perceptions of strict teacher behaviours were higher in Singapore, Korea and Brunei than in Australia and the USA, and much higher than the same scale for The Netherlands. Generally, learning in Asian classrooms is more teacher-centred and students are relatively more passive than their Western counterparts. Results obtained are supported by the Asian culture.

In a most recent application of the QTI, Wei, den Brok and Zhou (2009) used the QTI in an investigation of associations between English as a Foreign Language (EFL) teachers' interpersonal behaviour and students' fluency in English in secondary education in China. This was the first time the QTI was successfully translated and used in EFL classrooms. Confirmatory factor analyses supported the theoretical framework upon which the questionnaire is based.

The studies over the past two decades strongly supported the validity and usefulness of the QTI within the USA, Europe, Asia and Australia. In the present study, the Australian version of the QTI was used.

2.5 PAST STUDIES ON TEACHER INTERPERSONAL BEHAVIOUR–OUTCOME ASSOCIATIONS

Past classroom environment research has shown that students' perceptions of the learning environment account significantly in both cognitive and affective outcomes (Fraser, 1986; Haertel, Walberg & Haertel, 1981; McRobbie & Fraser, 1993). As two research questions in this present study focus on associations between student outcomes and teacher-student interactions, past studies of outcome-teacher behaviour associations are reviewed in this section.

An investigation of relationships between perceptions on the QTI scales and student learning outcomes (Wubbels, Brekelmans & Hooymayers, 1991) in The Netherlands revealed that the more the teachers demonstrated strict, leadership and helping/friendly behaviour, the higher the cognitive outcomes scores. Conversely, students responsibility and freedom, uncertain and dissatisfied behaviours were related negatively to achievement. These studies have indicated that interpersonal teacher behaviour is an important aspect of the learning environment that is related strongly to student outcomes.

Rickards and Fisher (1998) studied relationships between teacher and student interpersonal behaviour and effects on student attitudes in mathematics using the QTI. The study involved students in grades 8, 9 and 10 mathematics classes in Australia and was composed of 405 students in 9 schools with their 21 teachers. In classes where the students perceived greater leadership and helping/friendly behaviours in their teachers, there was a more favourable attitude towards the class. The converse was true when the teacher was perceived as strict and dissatisfied. Generally, the dimensions of the QTI were found to be significantly associated with student attitude scores. In particular, students' attitude scores were higher in classrooms in which students perceived greater leadership and helping/friendly behaviours in their teachers' interpersonal behaviours.

A similar study, also using the QTI, investigated associations between secondary school science and mathematics students' perceptions of the classroom learning environment and attitudes and achievement (Fisher, Rickards & Fraser, 1996). The findings of these studies indicated a strong correlation between student attitudes and interpersonal teacher behaviour and a weaker correlation between cognitive achievement and interpersonal teacher behaviour.

In a Korean study by Kim, Fisher, and Fraser (2000), the cross-cultural validity of the WIHIC and the QTI was established by administering the Korean version of the questionnaires to 543 students in 12 different Korean schools. The same study also investigated associations between students' attitude to science and their perceptions of the classroom environment as assessed by the WIHIC and the QTI, and investigated gender-related differences in the students' perceptions. There were

positive relationships of classroom environment and interpersonal teacher behaviour with students' attitudinal outcome. Relative to girls, boys perceived their learning environments and their teachers' interpersonal behaviour more favourably and reported more favourable attitudes toward their science classes. Generally, students' perceptions of the learning environment and the teachers' interpersonal behaviour suggest that students should receive more teacher support and involvement in the teaching/learning process and cooperate with other students more than at present. Also, teachers' behaviours could be changed to be more helping/friendly and understanding in order to cater for the students' interests.

In a separate study, Lee, Fraser, and Fisher (2003) used a translated Korean version of the QTI with 439 high school students in Korea and found associations between teacher-student interactions and classroom environment.

In an effort to assess the effectiveness of constructivist teaching on improving learning environments in Thai secondary school science classrooms, research results showed associations between students' attitude towards science and classroom learning environments (Puacharearn, 2004) This study comprised a sample of 606 students in 17 classes, responding to CLES.

In Taiwan, there were strong associations between the scales of the Teacher Communication Behaviour Questionnaire (TCBQ) instrument (She & Fraser, 2002a) in the Chinese language and students' attitudes about science, and two of the scales were associated with cognitive achievement. This instrument has added an additional aspect to research on teacher-student interactions by focusing on the use of verbal and non-verbal feedback to enhance students' attitudes toward science and their academic achievement outcomes (She & Fisher, 2002a).

In Brunei, Majeed, Fraser and Aldridge (2002) reported strong support in correlations between student satisfaction and scales of the MCI among 1,565 mathematics students from 81 classes in 15 government secondary schools in Brunei Darussalam. Correlations between science attitudes and scales of the WIHIC and QTI in 1,188 Form 5 science students has also been reported (Khine, 2001; Khine & Fisher, 2001).

The impact of teachers' interpersonal behaviour on examination results was examined by Scott and Fisher (2001) associations between QTI scales and enjoyment of lessons which in turn impact on the cognitive achievement was found. A sample comprising of 3,104 students in 136 classrooms in 23 typical, co-educational schools was used. Associations between students' perceptions of their teachers' interpersonal behaviours and their external exam result in science were investigated for a subsample of students who sat a national end-of-primary external science examination. Positive and negative correlations were found between cooperative and submissive teacher behaviors, respectively, in Brunei primary science classrooms.

In an earlier study, also in Brunei Darussalam, relationships for achievement and attitudes with scales of WIHIC, QTI and SLEI were also established with a sample of 644 chemistry students in 35 classes (Riah & Fraser, 1998b).

Another study (den Brok, Scott, & Fisher, 2005) investigated relationships between students' perceptions of their teachers' interpersonal behaviour and their subject-related attitude in primary science classes in Brunei. Teacher-student interpersonal behaviour was mapped with the QTI and reported in terms of two independent dimensions called Influence (teacher dominance vs submission) and Proximity (teacher cooperation vs opposition). While prior research using the QTI mainly focused on secondary education, the present study was one of the first in Brunei and in primary education and one of few studies to use multilevel analysis. Data from 1,305 students from 64 classes were used in this study. Results indicated strong and positive effects of Influence and Proximity on students' enjoyment of their science class and supported findings of earlier work with the QTI.

Using a sample of 1,512 primary school students in Singapore, Goh and Fraser (1998) reported relationships between a variety of student outcomes and students' classroom environment perceptions as assessed by the MCI and QTI. Positive associations between student attitudes and learning environment among 1,592 final-year secondary chemistry students from 56 classes in 28 schools in Singapore were found in Wong and Fraser (1996).

Relationships between the chemistry laboratory classroom environment and teacher-student interaction and student attitudes toward chemistry for 200 gifted secondary-school students were reported in Singapore (Quek, Wong, & Fraser, 2005a; 2005b). Two questionnaires, Chemistry Laboratory Environment Inventory (CLEI) and Questionnaire on Chemistry-Related Attitudes (QOCRA), were administered in these studies.

Koul and Fisher (2005) reported on the results of a large-scale study aiming to determine associations between science students' perceptions of their interactions with their teachers, the cultural background and the gender of the students and their attitudinal and cognitive achievement scores, in Jammu, India. A sample of 1,021 students from 31 year nine and ten science classes in seven schools completed an already existing and widely used instrument the Questionnaire on Teacher Interaction (QTI), an attitude scale and question relating to the cultural background of students. Positive associations were found between students' attitude towards science and perceived helping/friendly teacher behaviour in class. On the other hand, student responsibility and freedom, uncertain and dissatisfied behaviours of teachers had adverse effects and a negative association with student cognitive outcomes (Koul & Fisher, 2005).

Statistically significant associations were found with cognitive achievement and scales of the QTI. It was also noted that associations between attitudes and QTI scales were consistently higher than those values for the cognitive achievement. In general, cognitive achievement was higher where the teachers demonstrated more understanding behaviours and less uncertain, dissatisfied and admonishing behaviours.

Kokkinos, Charalambous and Davazoglou (2009) recently provided a cross-cultural validation of a Greek translation of the QTI and similarly it has been translated and validated for use in Turkey (Telli, den Brok, & Cakiroglu, 2007) and China (Wei, den Brok, & Zhou).

2.6 USE OF QTI TO ESTABISH TEACHER TYPOLOGIES

In an early application with the QTI, a typology of eight types (on the basis of Dutch data) of teacher communication style could be identified: (1) directive, (2) authoritative, (3) tolerant/authoritative, (4) tolerant, (5) uncertain/tolerant, (6) uncertain/aggressive, (7) repressive and (8) drudging (Wubbels & Levy, 1991). The idea of examining typologies is used in this thesis.

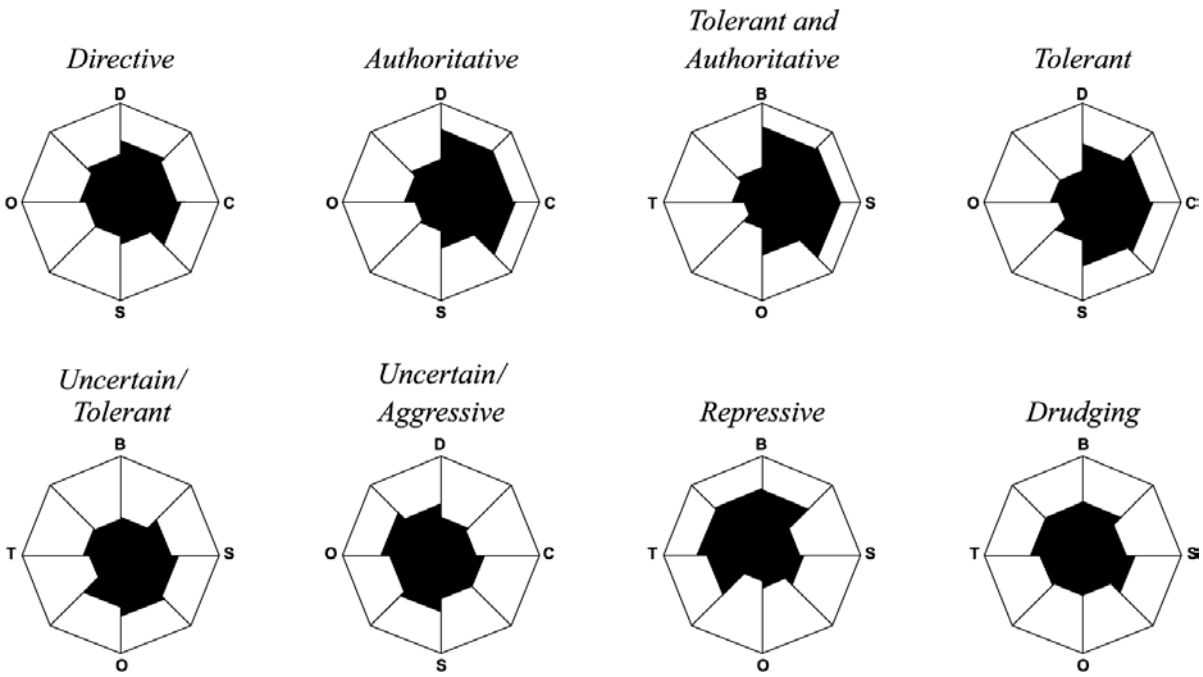
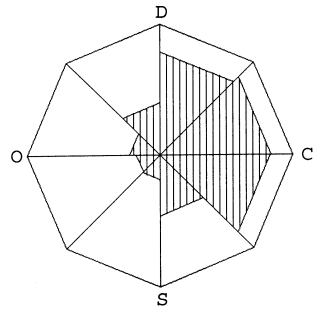
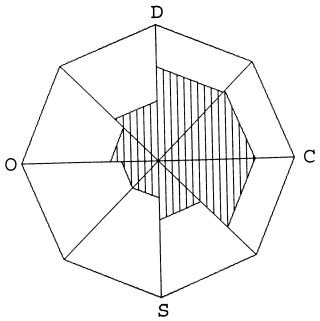


Figure 2.3. Eight types of typology of teacher communication style (Wubbels & Levy, 1993, pp. 48-49)

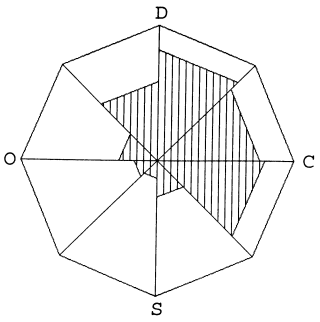
The typology research was replicated in Australia (Rickards, den Brok, & Fisher, 2005) and varied slightly from the one previously published by Wubbels and Levy (1993). The Australian typology contained the following types: (1) tolerant-authoritative (2) authoritative (3) directive-authoritative (4) directive (5) supportive (6) flexible (7) uncertain-aggressive. The existence of such typologies allows researched profiles to be matched to them and this is done in the research described in this thesis.



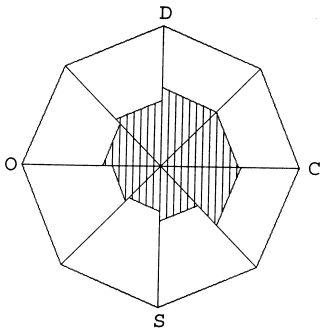
Tolerant/Authoritative



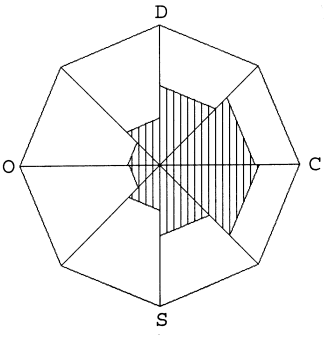
Authoritative



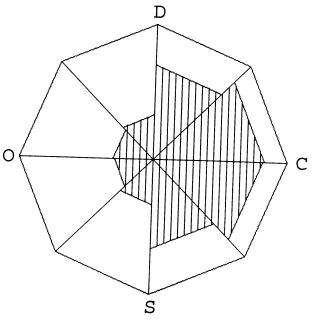
Directive/Authoritative



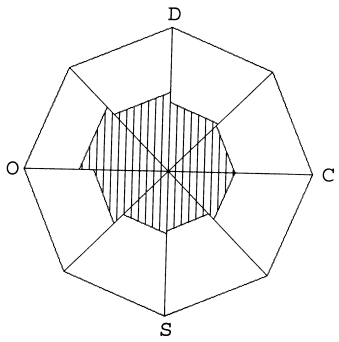
Directive



Supportive



Flexible



Uncertain/Aggressive

Figure 2.4. Graphical depiction of the sample cluster solution in terms of the eight QTI scales. (Rickards, den Brok, & Fisher, 2005, p. 281)

2.7 STUDENT ATTITUDES

In recent education research, much attention has been focused on affective outcomes, particularly attitudes, from the view that affective variables are as important as cognitive variables in influencing, possibly predicting, learning and other outcomes (Koballa, 1988). Throughout the past two decades, science educators have been

struggling with defining science attitudes (Shrigley, Koballa, & Simpson, 1988) and differentiating among attitudes, beliefs and values (Koballa, 1988). Many characteristics were used to describe attitudes, such as interest, enjoyment, and satisfaction (Gardner & Gauld, 1990) and even curiosity, confidence, and perseverance (Shulman & Tamir, 1972). It was generally agreed that attitude is not innate, but learned as part of culture (Shrigley, 1983).

Klopfer (1976) narrowed the multiple meanings attached to the term *attitude to science* to six different categories of mental disposition. These categories were: manifestation of favourable attitudes to science and scientists; acceptance of scientific enquiry as a way of thought; adoption of scientific attitudes; enjoyment of science learning experiences; development of interest in science and science-related activities; and development of interest in pursuing a career in science (Shulman & Tamir, 1972). The Test of Science Related Attitudes (TOSRA), designed to measure these scales separately, was subsequently developed for use with secondary school students (Fraser, 1978, 1981).

The TOSRA was initially developed in Australia by Fraser (1978). The final version of TOSRA has seven scales of 10 items each. The scales are: Social Implications of Science, Normality of Scientists, Attitude toward Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science.

The TOSRA quickly gained popularity as a useful instrument in learning environment research due to its ease of use and also its ability to measure learners' attitudes from different angles. In a quantitative synthesis on attitudes toward science, Haladyna and Shaughnessy (1982) declared that the TOSRA is "an outstanding instrument because it has a sound theoretical basis and an impressive empirical validation". Shrigley (1983) recommended the TOSRA, especially if someone is interested in measuring more than one dimension of attitudes toward science.

Since the achievement of favourable attitudes is widely held as an important aim of science education, the TOSRA could be used by teachers, curriculum evaluators, or researchers to monitor student progress toward achieving attitudinal aims. The

TOSRA could be used for measuring the status of individual students or groups, or for providing information about changes in student attitudes over a period of time. Furthermore, a major advantage that TOSRA has over some other science-related attitude tests is that it yields a separate score for a number of distinct attitudinal aims instead of a single overall score, thus making it possible to obtain a profile of attitude scores for each individual or group. Another important advantage in using the TOSRA is its economy, since it is suitable for group administration and since this instrument of seven scales can be easily administered within the duration of a normal class lesson.

2.8 TEACHING GIFTED CHILDREN IN SINGAPORE

Many past research studies have been conducted to develop effective teaching strategies for gifted children. The gifted curriculum in Singapore employs a number of strategies recommended to cater to different needs of these students. Presently, the screening and identification process of gifted children is confined to areas of mathematics, English language and general ability and there is no testing extended to the sciences, art or music. In the classroom scene, two common types of giftedness come across frequently – creative giftedness and academic giftedness. Creative children tend to be free thinkers and have imaginative intelligence whereas academically gifted children have the capacity to manage information and are outstanding academic achievers (Sak, 2004).

Whether locally or globally, the purpose of gifted education in children is to support the creative development and maximise the learning potential of each child, developing both self and areas of giftedness. In order to ensure quality outcomes for gifted students in classrooms, it is important that teachers understand the nature of the gifted learner as well as particular strategies that address their needs. Many teaching strategies are employed in teaching gifted children in Singapore to think including inculcating metacognitive skills using Paul's elements of reasoning, Bloom's taxonomy of educational objectives, Socratic questioning techniques and learning by scientific inquiry. Other teaching models such as creative problem solving and Hilda Taba's teaching strategies are also used. The differentiated

curriculum also addresses the affective domain where civic and moral education is emphasized.

A recent German study (Preckel & Brull, 2008) on grouping gifted children reported that there is a significant association between academic self-concept and class membership and gender. A decrease in academic self-concept was largest for girls in special gifted classes. This German study on grouping gifted children in class revealed that when girls were a minority in gifted classes, they tended to have lower academic self-concepts than did theboys. Hence, grouping according to gender in a class with more boys needs to be considered with care.

A noteworthy point to highlight that warrants educators' and parents' attention is that many gifted children have accompanying learning disabilities such as Asperger's Syndrome, Attention Deficit Hyperactivity Disorder (ADHD) and other attention deficit disorders, dyslexia, and autism (Weinfeld, Barnes-Robinson, & Jeweler, 2006). It is not surprising to see that gifted students without learning disabilities have a sense of independence while those with learning disabilities require frequent teacher support and feedback in deficit areas, though being highly independent in other areas at the same time. These students often appear to be extremely stubborn and inflexible. It is important to ensure that school officials and teachers are modifying the curriculum and learning environment to accommodate learning disabilities while developing the strengths of gifted students. In addition, these students must be nurtured to understand and overcome their own learning challenges.

Gifted education in Singapore prepares teachers and parents in the fields of gifted education and special education, including raising their awareness of gifted and talented students, learning disabilities and bright underachieving students. Gifted children educators and policymakers are also aware that the general screening for giftedness, done in primary school, may miss many gifted students with learning disabilities because the disability and giftedness will mask each other. Hence, parents and teachers are extra vigilant in identifying and serving these children with all available resources, otherwise their gifts will never be developed. Teacher behaviour and its associations form an important part of the gifted learning environment, complementing effective teaching strategies for metacognition. This research

pioneers this first study of teacher-student interaction in the gifted classroom, tapping on and extending from experiences derived from past learning environment and gifted education researches.

2.9 CHAPTER SUMMARY

Studies in the field of learning environments have made important contributions to the global field of education. It enables educators and policy-makers to refine and reform educational programmes to cater to the cognitive and affective needs of learners today. This chapter has discussed the historical background of learning environment questionnaires, in particular, the QTI. Research studies have shown the significant value of combining quantitative and qualitative methods in studies in order to provide a more comprehensive picture of the classroom learning environment. Past studies in classroom learning environments and their associations with student outcomes were noted.

This chapter also includes a section on past studies which used the QTI for gauging students' perceptions of teacher-student interpersonal behaviour, as well as the TOSRA for measuring students' science attitudes, to add value to this present research study.

The research study described in this thesis is distinctive as this is a unique study of gifted children in their science classes. It associates the response of these students to the QTI and an assessment of science attitudes and measurement of cognitive outcomes, which provides practical applications in the science classrooms.

The following chapter describes the research methods used in the present study, including details about how the study was administered.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This is the first study of teacher-student interaction and its associations with a sample of gifted students from primary school science classrooms that has been conducted, using the Questionnaire on Teacher Interaction (QTI). Both quantitative and qualitative methods of data collection were employed.

3.2 RESEARCH QUESTIONS

The purpose of this section is to transform the objectives shown in section 1.3 into research questions for this study. Since the QTI and the three attitude scales adapted from TOSRA have not been validated with primary gifted students in science classes in Singapore, the validation of the QTI and these attitude scales is essential in this study. This leads to the first two research questions.

Research Question 1

Is the QTI a valid and reliable questionnaire for use in primary science gifted classrooms in Singapore?

Research Question 2

Are the three Attitude scales adapted from the TOSRA valid and reliable scales for use in primary science gifted classrooms in Singapore?

Many past research studies have investigated student perceptions of the learning environment in classrooms and teacher-student interactions, both in the West and in the Asia Pacific region (Fraser, 1998a, b). It is of interest to determine the

perceptions of students in these classrooms. This gives rise to the formulation of the third research question.

Research Question 3

What are gifted students' perceptions of their science teachers' behaviours in their classrooms?

The strongest tradition in past classroom environment research has involved investigation of associations between students' perceptions of psychosocial characteristics of their classrooms and their cognitive and affective learning outcomes. Fraser's (1994) tabulation of 40 past studies shows that associations between a variety of cognitive and affective outcome measures and classroom environment perceptions have been replicated using a variety of classroom environment instruments and samples ranging across numerous countries and grade levels. For example, the Questionnaire on Teacher Interaction (QTI) has been used to determine associations between students' outcomes and perceived patterns of teacher-student interaction and the results have been reported for various samples (Fisher, Fraser, & Rickards, 1997; Fisher, Henderson, & Fraser, 1995; Goh, Young & Fraser, 1995). Therefore, the fourth research question was:

Research Question 4

Are there any associations between gifted students' perceptions of teacher interpersonal behaviour and student attitudinal and cognitive outcomes?

It was also of interest to examine whether there was any difference in how students perceive their teachers and the teachers perceive themselves. Hence the fifth research question was posed:

Research Question 5

Are there any differences between gifted student and teacher perceptions?

After investigating the perceptions of gifted students of their science teachers' behaviours and their associations, it is of interest to investigate the general typology of science teachers in the Singapore GEP. With this objective in mind, research question six was posed.

Research Question 6

What are the types of science teachers in the GEP in Singapore, based on the Australian QTI-based typologies?

Bearing in mind past learning environment studies which consistently have shown gender difference in students' perceptions of their learning environment (e.g., Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 2000; Wong & Fraser 1996), students were asked to indicate their gender when responding to the questionnaires. This led to an interest to investigate differences in students' perception of their science teachers with respect to student gender, thus forming the basis for last research question.

Research Question 7

Are there any gender-related differences in perceptions of gifted students' in their science classes?

3.3 INSTRUMENT SELECTION

Questionnaires are often used to survey opinions from large numbers of people who provide anonymous replies. This method is a quick and effective way of gathering a great deal of information from people. The items in a questionnaire are standardised and usually the respondents are randomly selected. For reasons presented in the literature review, the QTI and three attitude scales were selected for this study.

3.3.1 QTI

The 48-item version of QTI and three 10-item Attitude scales were used in this study (Fisher, Henderson & Fraser, 1995; Fraser, 1981) to investigate teacher-student interactions and their effects on student outcomes. This section notes the selection of the Attitude scales and the use of these scales and the QTI for the construction of reliable measurement scales.

3.4 RELIABILITY AND VALIDITY OF THE QTI

In this section, the reliability and validity of the QTI is discussed by using examples from previous studies. Research which originated in the Netherlands focused on the nature and quality of interpersonal relationships between teachers and students (Wubbels & Brekelmans, 1998; Wubbels & Levy, 1993). Subsequently, research with the QTI has been completed at various grade levels in the USA (Wubbels & Levy, 1993) and Australia (Fisher, Henderson & Fraser, 1995). Table 3.1 illustrates statistics of the internal consistency values of the QTI scales in six different countries.

Table 3.1

Comparison of the Alpha Reliability Coefficients (Internal Consistency) for the QTI Scales in Six Different Countries

	Alpha Reliability Coefficients					
Scale	USA[a]	Australia[a]	Netherlands[a]	Brunei[b]	Singapore[c]	India[d]
Leadership	0.80	0.83	0.83	0.69	0.81	0.71
Helping/ Friendly	0.88	0.85	0.90	0.80	0.88	0.65
Understanding	0.88	0.82	0.90	0.64	0.82	0.72
StuResp/ Freed	0.76	0.68	0.74	0.58	0.50	0.49
Uncertain	0.79	0.78	0.79	0.58	0.66	0.62
Dissatisfied	0.83	0.78	0.86	0.77	0.87	0.72
Admonishing	0.84	0.80	0.81	0.70	0.63	0.58
Strict	0.80	0.72	0.78	0.62	0.64	0.53
Students	*n* =1,606	*n* =792	*n* =1,105	*n* =1,188	*n* =720	*n* =1,021
Classes	*n* =66	*n* =46	*n* =66	*n* =54	*n* =20	*n* =31

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

b Source: Riah & Fraser (1998b)

c Source: Fisher et al. (1997)

d Source: Koul (2003)

As for other learning environment questionnaires, the ability of the QTI to differentiate between classrooms was considered to be important. Table 3.2 shows the variance in QTI scores using the ANOVA eta^2 statistic with class membership as the main effect. Each scale of the QTI significantly differentiated between the perceptions of students in different classrooms in five different countries.

Table 3.2

Comparison of the Amount of Variance Accounted for by Class Membership (Eta^2) for the QTI in Five Countries

	ANOVA Eta^2				
Scale	USA[a]	Australia[a]	Netherlands[a]	Brunei[b]	India[c]
Leadership	0.41*	0.48**	0.59*	0.18**	0.13**
Helping/Friendly	0.22*	0.33**	0.48*	0.27**	0.14**
Understanding	0.28*	0.29**	0.43*	0.22**	0.20**
StuResp/ Freed	0.29*	0.28**	0.36*	0.21**	0.13**
Uncertain	0.38*	0.38**	0.59*	0.22**	0.25**
Dissatisfied	0.19*	0.20**	0.39*	0.33**	0.18**
Admonishing	0.25*	0.25**	0.39*	0.39**	0.21**
Strict	0.43*	0.30**	0.45*	0.30**	0.16**
Students	*n* =1,606	*n* =792	*n* =1,105	*n* =1,188	*n* =1,021
Classes	*n* =66	*n* =46	*n* =66	*n* =54	*n* =31

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

a Source: Wubbels & Levy (1993) b Source: Riah & Fraser (1998b)

c Source: Koul (2003)

The QTI has been used in several large-scale studies in Asia, Goh pioneered the use of the QTI in a simplified form in Singapore with a sample of 1512 primary mathematics students in 39 classes in 13 schools (Goh & Fraser, 1996, 1998, 2000). This study cross-validated the QTI for use in a new country and found it useful in several research applications. Also, further support for the validity and usefulness of the QTI in Singapore is provided by Quek, Fraser and Wong's (2001) study among 497 gifted and non-gifted chemistry students and by Fisher, Goh, Wong, and Rickards' (1997) study involving 20 secondary science classes.

Scott and Fisher (2001) translated the QTI into Standard Malay and cross-validated it with 3104 primary school students in 136 classes in Brunei Darussalam. An English version of the QTI has been cross-validated for secondary schools (Khine & Fisher, 2002) and 644 chemistry students (Riah & Fraser, 1998). In Korea, Kim, Fisher and Fraser (2000) validated in Korean-language version of the QTI among 543 Grade 8 students in 12 schools, and Lee and Fraser (2001) provided further cross-validation information for the QTI using a sample of 440 Grade 10 and 11 science students. In Indonesia, Soerjaningsih, Fraser and Aldridge (2001) translated the QTI into Behasa Indonesia and cross-validated it with a sample of 422 university students in 12 research methods classes.

Therefore, the QTI can be regarded as a reliable and valid questionnaire that can be used with confidence.

3.5 RELIABILITY AND VALIDITY OF TOSRA

The Test of Science-related Attitudes (TOSRA) is a 70-item test in a Likert type format (Likert, 1932). It consists of seven scales with ten items for each. These scales are (1) Social Implication of Science, (2) Normality of Scientists, (3) Attitude to Scientific Inquiry, (4) Adoption of Scientific Attitudes, (5) Enjoyment of Science Lessons, (6) Leisure Interest in Science, and (7) Career Interest in Science. The scales are based on Klopfer's (1971) conceptual classification of the affective aims for science education.

Previous published research has shown the TOSRA to be a valuable instrument in Australia (Fraser & Butts, 1982). Khalili (1987) also cross-validated the TOSRA with a sample of 360 (11^{th} and 12^{th} grade students) in three high schools in suburban Chicago. This instrument has been widely used in the past three decades to measure attitudes related to the study of science.

Some of the numerous research studies that have successfully adapted scales from the TOSRA include Wong and Fraser (1996), Farenga and Joyce (1998) in Singapore; She and Fisher (2002b) in Taiwan, Soerjaningsih et al. (2001) in Indonesia, and Scott and Fisher (2001) in Brunei.

3.5.1 Selection of the Attitude Scale

Three scales, Attitude to Scientific Inquiry, Adoption of Science Attitude and Enjoyment of Science Lessons were adapted from the TOSRA to examine students' attitude towards science. These scales formed a 30-item component in the survey given to the students.

3.6 SAMPLE SELECTION

P5 students were chosen for this study as this was the second year of science in the GEP. These students would have been familiar with science and test requirements and the demands of answer quality in cognitive tests. In the year of 2007, there were a total of 498 P5 students in the gifted programme. The MOE only gave permission for a fraction of these students to participate in this study. Six schools were selected – two boys and four co-educational schools. The only girls' school that offers GEP was not selected as the usual science teacher was away for the entire semester for family commitments. Her place was filled by a temporary relief teacher. Finally, the sample consisted of a total of 279 students from 15 classes who completed the QTI questionnaire and the three 10-item Attitude scales during the first semester of 2007.

3.7 DATA COLLECTION

Both quantitative and qualitative data were collected in this study. Data collection spanned three months in semester 1 of the academic year 2007 to ensure there was consistent duration of classroom interaction and rapport among teachers and students. The researcher was personally involved in all interviews and classroom observations.

Initially, a request to collect data from all nine schools was submitted, but this was turned down by MOE. Finally, an appeal was made through the researcher's school principal and permission to obtain data from six schools was granted.

Once MOE had given its approval, a letter was sent to the respective principals of these schools for the researcher to visit the school for quantitative and/or qualitative data gathering.

The researcher also conducted a briefing with the science teachers from the respective schools about the administration of the QTI and Attitude scales questionnaire. Teachers administering the questionnaires were allowed to explain the scales to their students in the event of any doubts. Students were not required to give their names on their questionnaires.

During the day of the briefing, the researcher also took the opportunity to administer the QTI versions of Teacher Self and Ideal Teacher to all P5 science teachers of the six participating schools. The Teacher Self version of the QTI asks the science teacher to describe her/his behaviour in her/his own class, while the Ideal Teacher questionnaire reveals how this teacher would expect an ideal teacher to behave in the same situation.

In view of the tight P5 curriculum, teachers from most schools are not keen to use their curriculum time for interview and lesson observation. Fortunately, four school teachers agreed to arrange willing students for interview and among them, three agreed to be filmed in lesson observations. The researcher was very appreciative of their participation, being a P5 GEP teacher herself. The researcher also had to apply for time-off from her school to be personally involved in interviews and observations.

Permission to collect data from MOE took about three months, from application to processing and appeal, after the first rejection. Data collection took approximately another three months.

Qualitative data were carefully examined by the researcher seeking any complementary evidence to support any cognitive or attitudinal associations to teacher-student interactions.

The students' cognitive achievement was measured by a semester test constructed by the science teachers and the Gifted Education Branch. This was a standard, common test across all GEP schools, set by the Gifted Education Branch.

3.7.1 Quantitative Data Collection

Six primary schools providing GEP were selected for participation in this study. The QTI questionnaires, with three scales of the TOSRA - Attitude to Scientific Inquiry, Adoption of Scientific Attitude and Enjoyment of Science Lessons, were completed by the students during class time. These attitude scales attributed to a 30-item component in the whole survey. Student responses were given on a five-point Likert scale, scoring from 1 (Never) to 5 (Always) on the questionnaire.

The students' Semester 1 test results were taken as a measure of their cognitive achievement. This was a standard, common test across all GEP schools, set by the Gifted Education Branch.

Each participating school has only one P5 science teacher in the GEP. These six teachers accepted the invitation to attempt the Teacher Self and Ideal Teacher Questionnaire and all data collected were entered into a database for analysis using the SPSS software package.

3.7.2 Qualitative Data Collection

Groups of students from four of the schools were invited for interview. The class teacher selected two volunteers from each class on a random basis. The interviews were conducted separately in each school, in an informal atmosphere during curriculum hours.

The researcher took down notes of students' responses, as well as audio tape recordings of each interview, in an effort to make sure every part of the conversation containing vital information about classroom environment was captured. These interviews were also used to check whether students had responded to the questionnaire items on the basis intended.

Additionally, three science lessons from different classes of the above four schools were observed and filmed to provide any information from undergoing daily interactions that often go undetected in questionnaires or interviews.

3.8 DATA ANALYSIS

The data analysis focused primarily on the objectives of this study. Both quantitative and qualitative data were analysed and results interpreted.

3.8.1 Analysis of Quantitative Data

All quantitative data of the responses from the QTI, scales from the TOSRA and students' test scores collected were entered into an Excel spreadsheet to be imported in SPSS program for analysis. Any data which were missing by any student were treated as missing values by the SPSS program. Simple and multiple correlations, internal consistency (Cronbach alpha coefficient) and standardised regression weights were examined. Statistics for the QTI and TOSRA scale reliability, discriminant validity and ability to differentiate between classrooms were completed using the individual student as the unit of analysis.

Relationships between the scales of Attitude to Science Inquiry, Adoption of Science Attitude, Enjoyment of Science Lessons and eight scales of QTI were examined using the Pearson's Correlation procedure. The simple correlation (r) describes a bivarate association between two variables and the multiple correlation (R) indicates the association between two variables when all other variables are controlled (Henderson, Fisher & Fraser, 1995). Both simple and multiple correlation analyses were used to determine associations between students' perceptions of teacher behaviour and students' attitudinal and cognitive outcomes. The standardized regression coefficient (β), which measures the association when the effect of other scales is held constant, was also studied.

Gender differences in the perception of students were examined by the using independent samples t tests.

3.8.2 Analysis of Qualitative Data

Notes and audio recordings were made during each interview and transcribed for the purpose of easy reference and further analysis. Trends and observations from

classroom were also noted and documented, to complement the qualitative data obtained from interviews.

3.9 PRIVACY, CONFIDENTIALITY AND ETHICAL CONSIDERATIONS

An application was made to the MOE for permission to collect data from six primary schools offering GEP. After obtaining the MOE's approval to collect data, a letter was sent to each of the Principals of the schools for permission to collect data from their school. This letter fully explained participation was entirely voluntary and the consent of parents whose children were to be interviewed had to be obtained.

Privacy and confidentiality was maintained during the collection of the data. The students were not required to identify themselves in the questionnaires. Each school was numerically coded for tracking and data input purposes only. Information about teachers and students was not used for comparative purposes in this current research.

The data have been stored electronically at the central facility provided at Curtin University of Technology. It is automatically backed up by that facility and will be kept for a period of five years. It is also archived in CD format for separate storage by this researcher. The questionnaires have been placed in secure storage with the researcher and will be destroyed five years after completion of this study.

All students interviewed are identified according to their register numbers. At the point of interview, the researcher did not refer their numbers to their names and their anonymity was ensured and emphasized during and after the interview.

Video recordings of classroom observation were captured and stored in DV tapes and CDs. These storage media will also be destroyed at the end of five years.

3.10 CHAPTER SUMMARY

The purpose of this study was to investigate teacher-student interactions in Primary 5 gifted science classes and their associations with cognitive and attitudinal outcomes.

The 48-item Questionnaire on Teacher Interaction (QTI), along with three 10-item scales adapted from TOSRA , relating to students' attitude were given out to students. Three forms of the QTI (Student, Teacher-Self, and Ideal Teacher) were used. The selected attitude scales were Attitude to Science Inquiry, Adoption of Science Attitude and Enjoyment of Science Lessons. The science class teachers of these participating students also attempted the QTI version about themselves (Teacher-Self) and their ideal science teacher (Ideal Teacher).

The students' cognitive achievement was measured by a semester test administered across all GEP schools, constructed by P5 GEP science teachers and GEB. Data was collected from six out of nine GEP primary schools in Singapore. There were a total of 279 respondents but this was reduced to 271 as a result of incomplete sets of data.

The data were analysed by means of the SPSS software package using descriptive statistics, analysis of variance, and simple and multiple correlations.

Supplementary information was provided through student groups interview and lesson observation. These qualitative data were not subjected to formal data analysis but used to give another perspective on teacher-student interactions and their effects on cognitive and attitudinal achievements.

CHAPTER FOUR

QUANTITATIVE RESULTS

4.1 INTRODUCTION

This chapter provides information that can be used to answer to the research questions proposed in Section 3.2 by showing the validity and reliability of the QTI and three attitude scales adapted from TOSRA when used with a Singapore sample in gifted primary science classrooms. The chapter then presents the results of applications of both questionnaires.

4.2 VALIDATION OF THE QUESTIONNAIRE ON TEACHER INTERACTION (QTI)

The 48-item version of the Australian QTI was used to examine gifted students' perceptions of teacher-student interpersonal behaviour in this study. A sample of 279 students responded to the 48-item QTI as well as the 30-item Attitude scales instrument.

4.2.1 Internal Consistency and ability to differentiate between classes

The internal consistency/reliability (Cronbach *a* reliability coefficient) of the QTI scales was calculated, using the individual student as the unit of analysis (see Table 4.1). The scale *a* coefficients range from 0.69 to 0.88, confirming the findings of previous studies (e.g., Fisher et al., 1993b, 1995; Waldrip & Fisher, 2003) indicating high internal consistency for the 48-item Australian version of the QTI when used with Primary 5 gifted science students.

Table 4.1

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

Scale	Cronbach Alpha Coefficient	ANOVA Results (Eta^2)
Leadership	0.83	0.05***
Helping/ Friendly	0.88	0.07***
Understanding	0.83	0.04***
Student Responsibility / Freedom	0.73	0.05***
Uncertain	0.69	0.05***
Dissatisfied	0.77	0.04***
Admonishing	0.77	0.05***
Strict	0.72	0.04***

The sample consisted of 279 science students in 15 classes.

The highest alpha reliability was obtained for the scale of Helping/Friendly and the lowest for Uncertain. In addition, one-way analysis of variance (ANOVA) was used to measure this instrument's ability to differentiate between classes. The eta^2 statistic was calculated to provide an estimate of the strength of the association between class membership and the dependent variables as shown in Table 4.1. The eta^2 statistics for the QTI indicate that the amount of variance in scores accounted for by class membership ranged from 0.04 to 0.07 and was statistically significant ($p < 0.001$) for all scales. Accordingly, students in the same classes responded to each item similarly, but those in other classes responded to them differently.

In addition, supplementary validation of the QTI can be achieved by checking if the interscale correlations adhere to the circumplex model.

Table 4.2 reports the inter-scale correlation of the actual QTI scales using the class mean as the unit of analysis. The circumplex model predicts that correlations between adjacent scales are expected to be the highest, but the correlation gradually decreases as the scales move further apart until opposite scales are negatively correlated. This pattern is clearly reflected in Table 4.2 and illustrated by Figure 4.1 that uses the Helping/Friendly scale as an example.

Table 4.2

Inter-scale Correlations for the QTI

	Lea (DC)	HFr (CD)	Und (CS)	SRes (SC)	Unc (SO)	Dis (OS)	Adm (OD)	Str (DO)
Leadership (DC)		0.73	0.76	0.40	-0.50	-0.54	-0.50	-0.23
Help/Friendly (CD)			0.78	0.57	-0.35	-0.55	-0.56	-0.35
Understanding (CS)				0.55	-0.40	-0.61	-0.67	-0.36
Stu Res / Free (SC)					-0.03	-0.30	-0.34	-0.45
Uncertain (SO)						0.46	0.44	0.10
Dissatisfied (OS)							0.70	0.51
Admonishing (OD)								0.50
Strict (DO)								

n = 269

The results of the inter-scale correlations from the study reflect the circumplex nature of the QTI. Upon closer inspection, the scale Helping/Friendly is correlated closely and positively with Leadership (0.73) and Understanding (0.78). This correlation decreases with other scales with the highest negative correlation being with the Admonishing scale (-0.56).

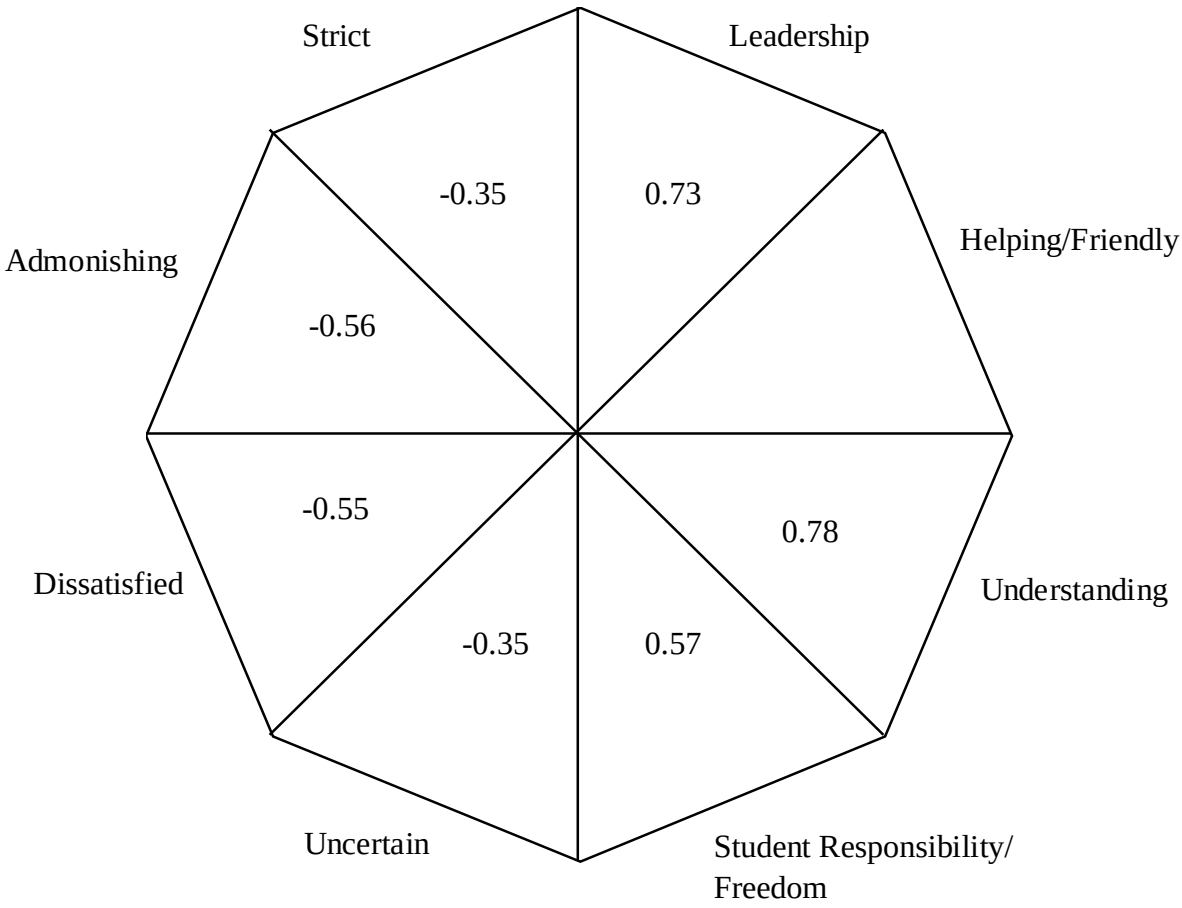


Figure 4.1. Correlation of Helping/Friendly scale with other QTI scales.

These results confirm the circumplex nature of the QTI model supporting its validity for use in Singapore primary GEP science classes. We can say with confidence that the QTI is a reliable instrument for use in Singapore in gifted primary classrooms.

Consequently, the validity and reliability results of the QTI from this study are consistent with the results from previous studies, for example in a number of the studies elsewhere with teachers and their students in The Netherlands, Tasmania, Australia and in the USA (Brekelmans, Wubbels, & Creton, 1990; Fisher, Henderson, & Fraser, 1995; Kent, Fisher, & Fraser, 1995; Rickards, Fisher, & Fraser, 1996; Wubbels & Levy, 1991).

4.3 VALIDATION OF THE ATTITUDE SCALES

Three scales, Attitude to Scientific Inquiry, Adoption of Scientific Attitude and Enjoyment of Science Lesson were adapted from the TOSRA to examine students'

attitude towards science, as described in Section 3.5.1. These three scales made up a 30-item instrument which was given to participating students along with the QTI. Each question was answered on a 5-point Likert scale from *Strongly Disagree* (score 1) to *Strongly Agree* (score 5).

Table 4.3

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

Scale	Cronbach Alpha Coefficient	Mean Correlation with other scales
Attitude to Scientific Inquiry	0.84	0.26
Adoption of Scientific Attitude	0.76	0.43
Enjoyment of Science lesson	0.96	0.36

The sample consisted of 279 science students in 15 classes. n = 279

In Table 4.3, the Cronbach Alpha coefficients of 0.76 to 0.96 show high internal consistency and hence the scales are highly reliable for use in the Primary 5 GEP science classroom. The discriminant validity, of 0.26 to 0.36 shows that the scales measure distinct but somewhat overlapping aspects of students' attitude range.

4.4 COGNITIVE ACHIEVEMENT

The cognitive achievement of gifted children has always been an important focus of the gifted education programme. Many efforts are constantly made to maximise the learning potential of each child. In GEP, students have to achieve a baseline score of 70% in tests and exams for mathematics and science. This research study investigated associations between the students' perceptions of teachers' interpersonal behaviour and their attitudinal and achievement outcomes. The associations were analysed by simple and multiple correlations, and results are reported separately for attitude and cognitive achievement outcomes.

In the present study, the associations between the perceived teacher behaviour and students' cognitive achievement are described in Section 4.4.1, while associations

between the students' perceptions of teacher behaviour and students' attitude are discussed in Section 4.5.

4.4.1 Association between Teacher-Student Interaction and the Cognitive Achievement of the Students

This section discusses the results of simple *(r)* and multiple *(R)* correlations used to analyse associations between the teacher interpersonal behaviour scales of the QTI and students' cognitive achievement. The standardised regression weight *(β)* reports the significance between cognitive achievement and each individual QTI scale when all other QTI dimensions are controlled. Students' semester test scores were used as measures of cognitive achievement.

Table 4.4

Associations Between QTI Scales and Cognitive Achievement in Terms of Simple Correlations (r), Multiple Correlations (R) and Standardized Regression Coefficients (β)

Scale	Test mark	
	r	*ft*
Leadership	0.21**	0.18
Helping/Friendly	0.13*	-0.16
Understanding	0.19**	-0.01
Student Responsibility/Freedom	0.12*	0.12
Uncertain	-0.09	0.07
Dissatisfied	-0.20**	-0.18*
Admonishing	-0.19**	-0.13
Strict	-0.03	0.16*
Multiple Correlation R = 0.28**		
R^2 = 0.08		

*p<0.05, **p<0.01

The simple correlation (*r)* figures in Table 4.4 indicate that there were six significant relationships (p<0.05, p<0.01), out of eight scales of the QTI. These associations were significantly positive for the scales of Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom for student cognitive achievement. The scales of

Dissatisfied and Admonishing displayed significantly negative associations. In summary, cognitive achievement was higher where the teachers were perceived to demonstrate more leadership, were helping, friendly and understanding, gave students responsibility and freedom and were less dissatisfied and admonishing.

An examination of the beta weights reveals that only two of the eight scales retained their significance. The Strict scale was positively associated and the Dissatisfied scale negatively associated with the cognitive achievement of the students.

The multiple correlation R and R^2 resulted in positive figures of 0.28** and 0.08, respectively. The R^2 figure in Table 4.4 suggests that 8% variance in the students' test results can be attributed to their perception of their teacher's interpersonal behaviour. The beta weight (β) values showed that Strict (0.16) (positive) and Dissatisfied (-0.18) (negative) behaviours have the greatest significant effects. ($p<0.05$)

This finding on Strict behaviour being statistically significantly associated with higher cognitive achievement is not surprising. In the Asian context, a teacher is usually perceived as strict if this teacher monitors his/her students very closely and expects the students to perform well in assessments. Remedial lessons are usually conducted when the students fall below the baseline level of 70% in tests. Hence, with close supervision, students are geared towards academic progress.

4.5 ATTITUDINAL ACHIEVEMENT

The investigation of associations between students' perception of their classroom learning environments and students' affective outcomes has provided a particular focus and rationale of learning environment research (Fraser, 1998a) and, bearing in mind the central role of pastoral care and the promotion of positive student attitudes in science classes, it was considered important that students' affective outcomes be investigated in this study.

Simple correlational analyses were performed separately for each affective student outcome, namely, Attitude to scientific inquiry, Adoption of scientific attitude and

Enjoyment of science lesson, to describe the bivariate association between each outcome scale and each scale of the QTI.

Table 4.5

Associations Between QTI Scales and Attitude Scales

Scale	Attitude to Scientific Inquiry	Adoption of Scientific Attitude	Enjoyment of Science lesson
	r	*r*	*r*
Leadership	0.19**	0.49**	0.62**
Helping/ Friendly	0.17**	0.41**	0.59**
Understanding	0.11	0.44**	0.59**
Student Responsibility / Freedom	0.09	0.17**	0.36**
Uncertain	-0.01	-0.31**	-0.34**
Dissatisfied	-0.08	-0.37**	-0.53**
Admonishing	-0.06	-0.37**	-0.55**
Strict	-0.05	-0.15*	-0.32**

*p<0.05, **p<0.01

The data, shown in Table 4.5 indicate that students who perceive their teachers as showing higher levels of leadership, helping/friendly and understanding behaviours and who give their students higher levels of freedom in the classroom have a more positive attitude towards science and have higher levels of enjoyment of science lessons. Conversely, students who perceive their teachers as showing higher levels of Uncertain, Dissatisfied, Admonishing and Strict behaviours have less positive attitudes towards science and have lower levels of enjoyment of science lessons.

4.5.1 Association between Teacher-Student Interaction and Attitude towards Scientific Inquiry

Standard regression weights (β) were used to identify which of the eight QTI scales contributed to the variance in student outcomes when the other environment scales were mutually controlled. The beta weights presented in Table 4.6 shows that Leadership scale was positively and significantly associated with attitude towards scientific inquiry. (p<0.05) The R^2 figure indicates that 3% of variance in students' attitude

towards scientific inquiry can be attributed to their perception of teacher's interpersonal behaviour.

Table 4.6

Associations Between QTI Scales and Attitude to Inquiry in terms of Simple Correlations (r), Multiple Correlations (R) and Standardized Regression Coefficients (β)

Scale	Attitude to Scientific Inquiry	
	r	*β*
Leadership	0.19**	0.25*
Helping/Friendly	0.17**	0.15
Understanding	0.11	-0.15
Student Responsibility/Freedom	0.09	-0.02
Uncertain	-0.01	0.10
Dissatisfied	-0.08	-0.01
Admonishing	-0.06	0.02
Strict	-0.05	-0.02
Multiple Correlation $R = 0.23$		
$R^2 = 0.03$		

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

4.5.2 Association between Teacher-Student Interaction and Adoption of Scientific Attitude

Table 4.7 reports the simple correlation (*r*) and the standardised regression weights (*β*) between adoption of scientific attitude and each individual QTI scale when all other QTI dimensions are controlled. The simple correlation (*r*) figures in the Table 4.7 indicate that all scales are significantly correlated ($p<0.05$, $p<0.01$) with the Adoption of Scientific Attitude scale. The beta weights presented in Table 4.7 suggest that students' positive attitude towards science was particularly evident when the students perceived higher levels of leadership behaviour in their teacher. Only the Leadership scale retained its significance and was positively and significantly associated with Adoption of Scientific Attitude in science classes. The R^2 figure indicates that a considerable 27% of variance in student adoption of scientific

attitude can be attributed to their perception of their teacher's interpersonal behaviour.

Table 4.7

Associations Between QTI Scales and Adoption of Science Attitude *in terms of Simple Correlations (r), Multiple Correlations (R) and Standardized Regression Coefficients (β)*

Scale	Adoption of Scientific Attitude	
	r	*β*
Leadership	0.49**	0.31***
Helping/Friendly	0.41**	0.07
Understanding	0.44**	0.10
Student Responsibility/Freedom	0.17**	-0.10
Uncertain	-0.31**	-0.03
Dissatisfied	-0.37**	-0.06
Admonishing	-0.37**	-0.10
Strict	-0.15*	0.03
Multiple Correlation $R = 0.52$***		
$R^2 = 0.27$		

*$p<0.05$, **$p<0.01$, ***$p<0.001$

4.5.3 Association between Teacher-Student Interaction and Enjoyment of Science Lesson

Table 4.8 reports the simple correlation (*r*) and the standardised regression weights (*β*) between enjoyment of science lesson and each individual QTI scale when all other QTI dimensions are controlled. The simple correlation (*r*) figures in the Table 4.8 indicate that all scales are significantly correlated ($p<0.05$, $p<0.01$) with Enjoyment of Science Lesson scale. The beta weights presented in Table 4.8 suggest that students' enjoyment of science lesson was particularly evident when the students perceived higher levels of leadership and helping/friendly behaviour in their teacher. Conversely, students who perceive their teachers as showing higher level of admonishing behaviour have lower level of enjoyment of science lessons.

β values showed that Leadership (0.36), Admonishing (-0.23), Helping/ Friendly (0.16) behaviours have the greatest significant effects. (p<0.05, p<0.01, p<0.001). The R^2 figure indicates that 48% of variance in the students' enjoyment of science lesson can be attributed to their perception of their teacher's interpersonal behaviour.

Table 4.8

Associations Between QTI Scales and Enjoyment of Science lesson in terms of Simple Correlations (r), Multiple Correlations (R) and Standardized Regression Coefficients (β)

Scale	Enjoyment of Science Lesson	
	r	*β*
Leadership	0.62**	0.36***
Helping/ Friendly	0.59**	0.16*
Understanding	0.59**	-0.04
Student Responsibility / Freedom	0.36**	0.03
Uncertain	-0.34**	0.04
Dissatisfied	-0.53**	-0.11
Admonishing	-0.55**	-0.23**
Strict	-0.32**	-0.01
Multiple Correlation R = 0.69***		
R^2= 0.48		

*p<0.05, **p<0.01, ***p<0.001

4.6 GENDER DIFFERENCE

The relationships between the students' perception of teacher interpersonal behaviour and the gender of the students were analysed. The gender differences in students' perceptions of teacher behaviour were examined by taking into account the number of male (211) and female (61) students involved in the study.

To examine the gender difference in students' perception of teacher interpersonal behaviour in science classes, the within-class gender subgroup mean was chosen as the unit of analysis which aims to eliminate the effect of class differences due to males and females being unevenly distributed in the sample. In the data analysis, male and female students' mean scores for each class were computed, and the

significance of gender differences in students' perceptions of teacher interpersonal behaviour analysed. Table 4.9 shows the scale item means, male and female differences, standard deviations and equality of variance values, to establish whether there are significant differences in perceptions of students due to their gender. Figure 4.2 illustrates these mean scores.

Table 4.9

Scale Means and Standard Deviations for Male and Female Science Students on the Eight Scales of the QTI and on the Attitude, Adoption and Enjoyment scales

Scale	*M*			*SD*		*F*
	Male	Female	Difference (M-F)	Male	Female	
Leadership	4.21	4.04	0.17	0.60	0.69	0.84
Helping/ Friendly	4.02	4.01	0.01	0.82	0.77	0.44
Understanding	3.93	3.99	-0.06	0.73	0.66	0.02
Student Responsibility / Freedom	2.64	2.46	0.18	0.72	0.67	1.26
Uncertain	1.55	1.60	-0.05	0.48	0.49	0.14
Dissatisfied	1.69	1.54	0.15	0.66	0.54	1.05
Admonishing	1.87	1.72	0.15	0.67	0.56	1.48
Strict	2.86	2.72	0.14	0.71	0.69	0.15
Attitude to Scientific Inquiry	3.93	3.99	-0.06	0.61	0.59	0.07
Adoption of Scientific Attitude	3.83	3.91	-0.08	0.56	0.45	2.88
Enjoyment of science lesson	3.95	3.98	-0.03	0.96	0.82	1.78
males: n = 211; females: n = 61						

In Levene's Test for Equality of Variance, the p-values were higher than 0.05 (p>0.05), hence gender difference was not statistically significant. There was no subsequent need to perform an independent samples t-test. These findings are supported by previous studies (Castillo et al. 2006; Henderson et al. 2000; Nair & Fisher 2000), which indicated that gender difference in students' perceptions of their learning environments typically are quite small.

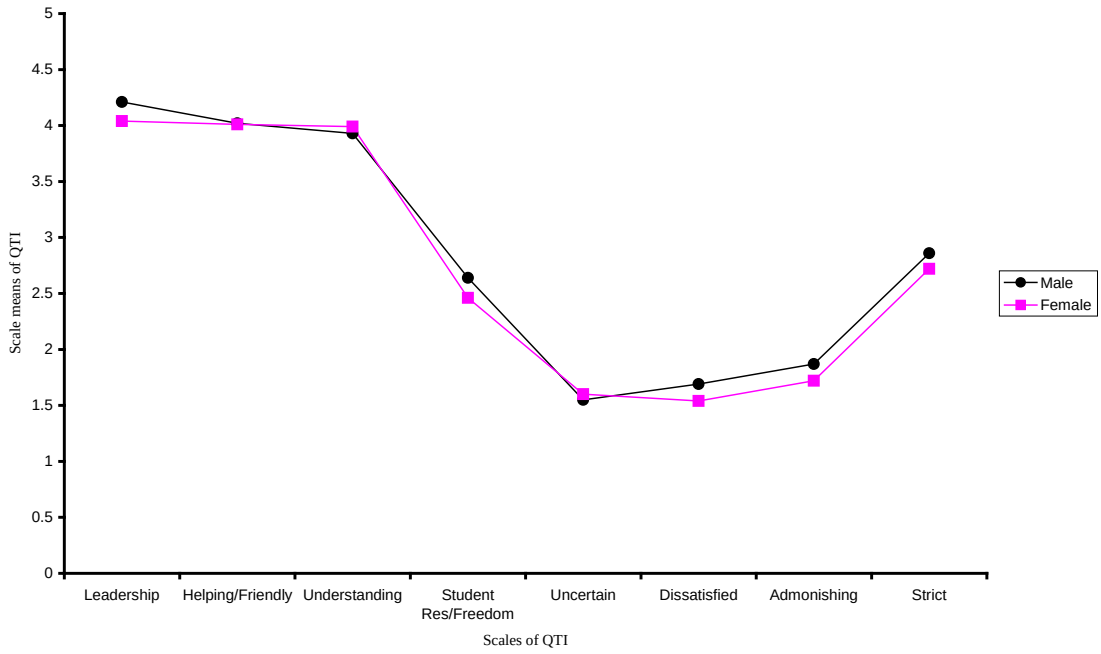


Figure 4.2. Scale means of male and female students.

4.7 TYPOLOGY OF SINGAPORE SCIENCE TEACHERS (GEP)

Research has shown that teachers' ideals have major influence on their self-perceptions (Wubbels, Brekelmans, & Hooymayers, 1992; Wubbels , Brekelmans, & Hooymayers, 1993). As a consequence, discrepancies between ideals and student perceptions of teacher behaviour will almost inevitably lead to discrepancies between teacher perceptions and student perceptions. Such differences in perception may lead to miscommunications or even conflicts in the classroom. In this present study, leadership ranks first in the eyes of the Singapore science teachers. This scale is supported by the highest mean value in Table 4.10. Other desirable characteristics included qualities being described by the Helping/Friendly and Understanding scales. Not surprisingly, teachers also perceive the ideal teacher to be reasonably strict with students, scoring a mean value of 3.14

Table 4.10

Means and Standard Deviations of the QTI of Teachers' Ideal

Scale	Mean	Standard Deviation
Leadership	4.89	0.09
Helping/Friendly	4.86	0.22
Understanding	4.81	0.22
Student Responsibility/Freedom	2.72	0.29
Uncertain	1.89	0.73
Dissatisfied	1.25	0.39
Admonishing	1.36	0.25
Strict	3.14	0.75

n = 6 teachers in 6 schools

Mean values and standard deviation of Singapore science teachers are presented in Table 4.11. Their self-perception of teacher behaviour is highest for Understanding scale, followed by Helping/Friendly and Leadership. Two out of eight scales have very close mean values which indicate that the teachers perceive themselves to be very close to their ideals in Uncertain and Strict scales, depicted by Figure 4.3.

Drawing upon the same graph in Figure 4.3, they perceive themselves as exhibiting less leadership, helping/friendly and understanding behaviours compared to their Ideal teacher and also higher in Dissatisfied and Admonishing behaviours than their ideal teacher.

Table 4.11

Means and Standard Deviations of the QTI of Teachers' Self

Scale	Mean	Standard Deviation
Leadership	4.11	0.36
Helping/Friendly	4.17	0.41
Understanding	4.22	0.70
Student Responsibility/Freedom	2.56	0.60
Uncertain	1.86	0.25
Dissatisfied	1.78	0.70
Admonishing	2.08	1.05
Strict	3.19	0.93

n = 6 teachers in 6 schools

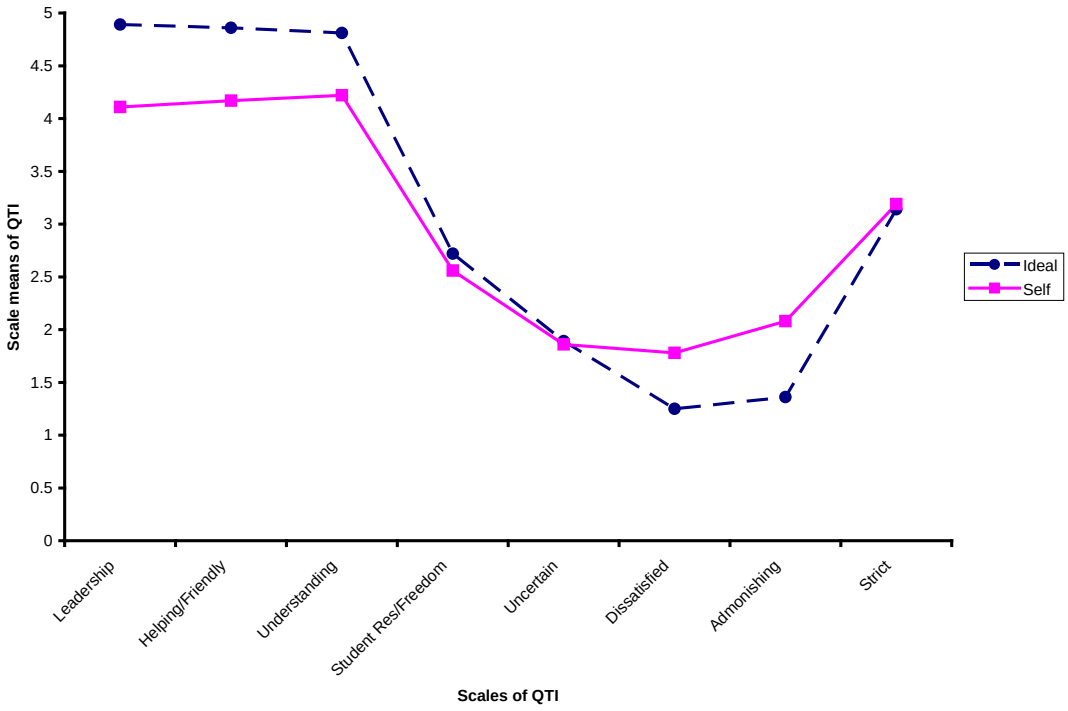


Figure 4.3. Teachers' self and ideal teacher perceptions.

It can be seen from Figure 4.4 that students perceived their teachers as displaying less leadership, helping/friendly and understanding behaviours than the teachers perceive themselves. Similarly, students also perceive their teachers exhibiting less uncertain, dissatisfied, admonishing and strict behaviours than the teachers. Two out of eight scales have the smallest mean difference in teacher self-perception and student perception, namely the Leadership and Student Responsibility/ Freedom scales. In this comparison, students perceive the teachers somewhat between the teachers' self-perception and teachers' ideal.

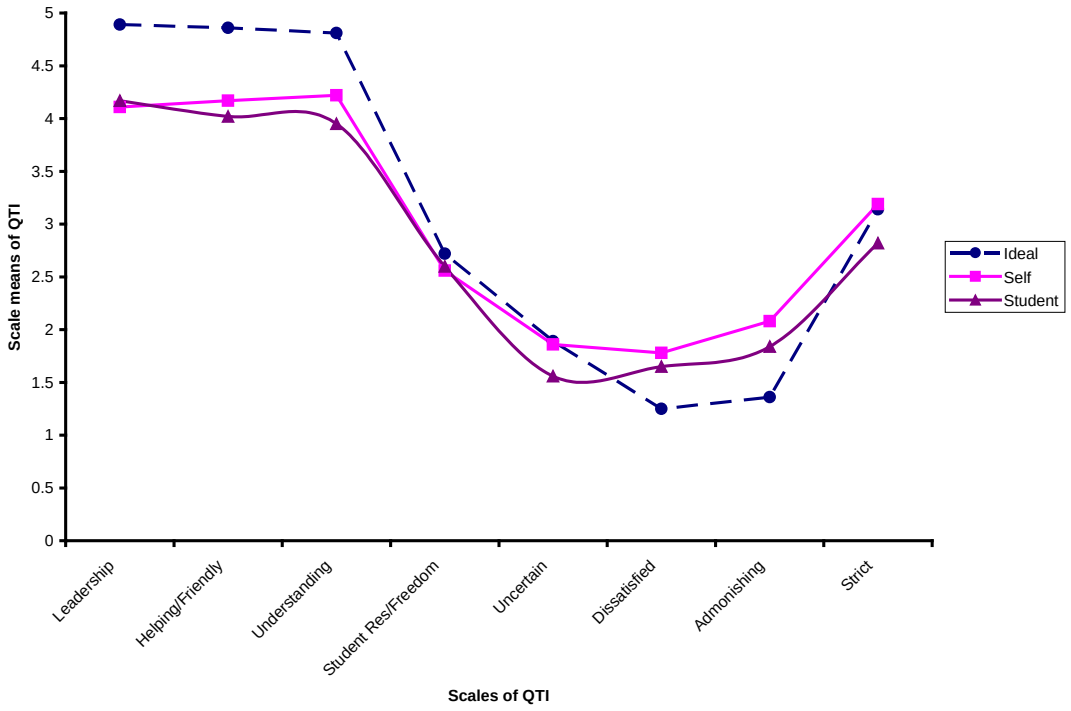


Figure 4.4. Teachers' self, ideal teacher and students' perceptions.

The QTI has also been used to develop typologies of teacher interpersonal behaviour in many countries such as The Netherlands, USA and lately, Australia. Wubbels, Brekelmans, Creton, and Hooymayers (1990) used cluster analysis and eight types of teacher were distinguished. The behavioural patterns on the eight-teacher types were characterised as Directive, Authoritative, Tolerant/Authoritative, Tolerant, Uncertain/Tolerant, Uncertain/Aggressive, Repressive and Drudging. Teacher types of profile from past studies can be associated with one of the typologies that have been identified above (Brekelmans, Levy, & Rodriquez, 1993). Teacher types associated with the greatest student cognitive and affective outcomes were directive -characterised by a well-structured task-oriented learning environment and tolerant/ authoritative - characterised by a pleasant well-structured environment in which the teacher has a good relationship with students. Aggressive/uncertain (characterised by an aggressive kind of behaviour) and uncertain/tolerant teacher types were associated with the lowest student outcomes.

Rickards, den Brok, and Fisher (2005) reported the first development in Australia of science teacher typologies of teacher-student interpersonal behaviour. Earlier work with the QTI in The Netherlands has revealed eight different interpersonal styles,

which were later confirmed with an American sample of secondary school teachers. The Australian study investigated the extent to which typologies found in earlier studies also apply to a sample of Australian secondary school science teachers where the determined Australian typology were compared with the earlier Dutch findings. This present study investigated the type of Singaporean primary science teachers, based on the Australian QTI-based typology.

A visual comparison of the graphical profiles of the Brekelmans' typology (Figure 4.5) and the Australian typology (Figure 4.6) indicated that four of the profiles in both typologies could be classified as similar. Looking at the graphical patterns as displayed in Figure 4.6, these teachers, in both samples could be classified as Tolerant/Authoritative (Australian type 1), Authoritative (Australian type 2), Directive (Australian type 4) and Uncertain/Aggressive (Australian type 7). The Australian typology of science teachers had seven behavioural patterns, characterised as Tolerant/Authoritative, Authoritative, Directive/Authoritative, Directive, Supportive, Flexible and Uncertain/Aggressive.

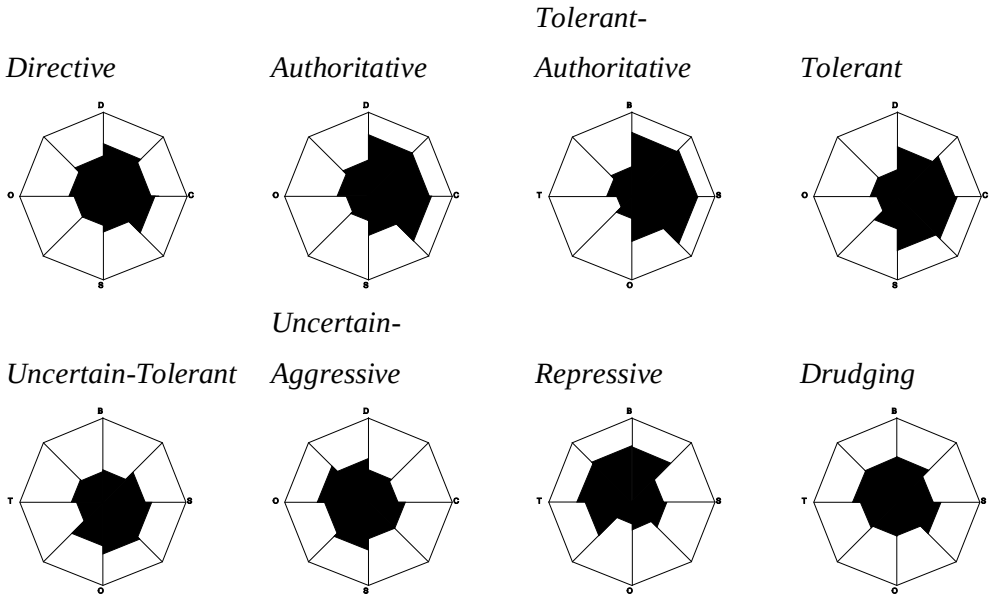
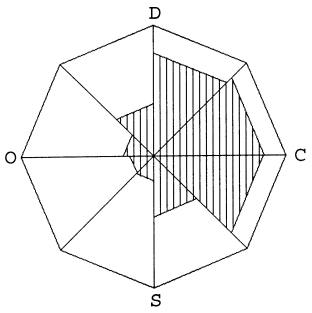
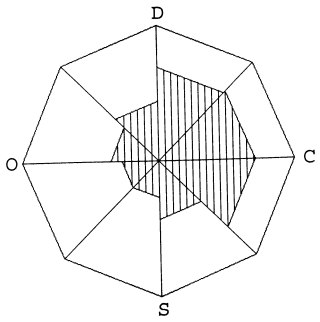


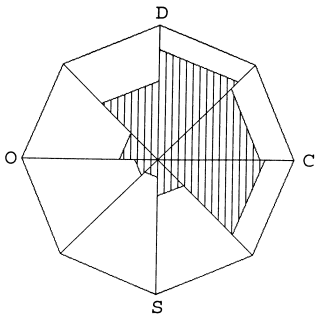
Figure 4.5. Graphic representations of the 8 types of patterns of interpersonal relationships. (Rickards, Brok, & Fisher, 2005)



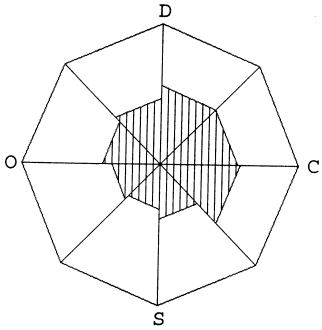
Type 1- Tolerant-Authoritative



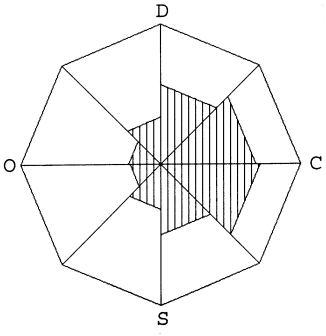
Type 2- Authoritative



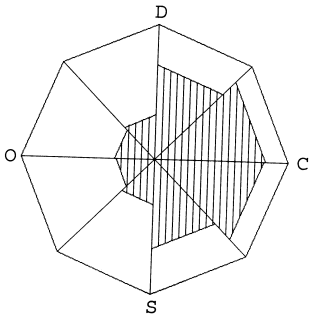
Type 3-Directive-Authoritative



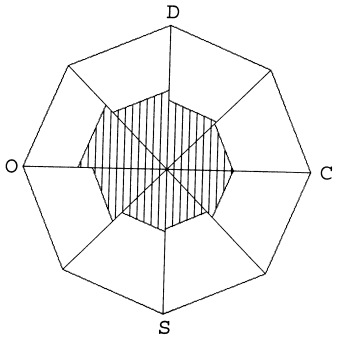
Type 4- Directive



Type 5- Supportive



Type 6- Flexible



Type 7- Uncertain- Aggressive

Figure 4.6. Graphical depiction of the typology of the Australian science teachers. (Rickards, Brok, & Fisher, 2005)

From Figure 4.9, it can be seen that the profile of Singapore GEP primary science teacher could be classified as Tolerant/Authoritative according to the Australian typology. This type of teacher behaviour brings about high cognitive and affective outcomes. There is a high rate of participation learning and also reality learning.

The profile of teachers' ideal was similar to Directive/Authoritative (in terms of Strict, Leadership, Helping/Friendly and Understanding scales) and Support (in terms of Admonishing, Dissatisfied, Uncertain and Student Responsibility/Freedom scales) in the Australian typology, as shown in Figure 4.7.

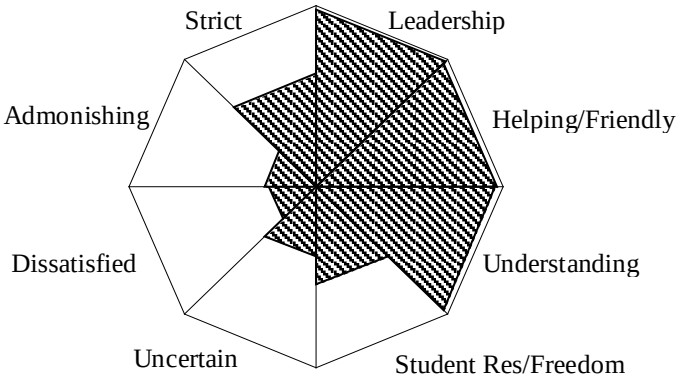


Figure 4.7. Profile – Ideal teacher.

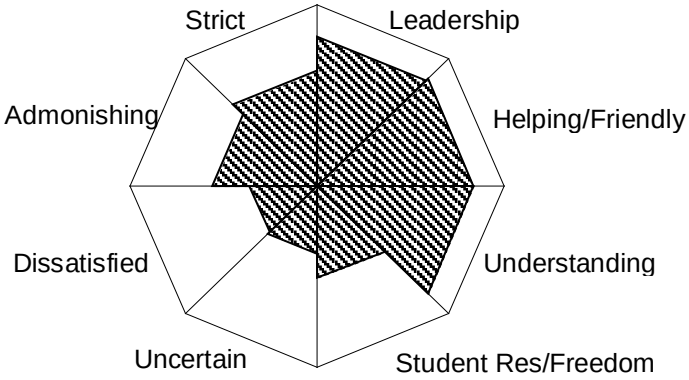


Figure 4.8. Profile – Teacher Self-perception.

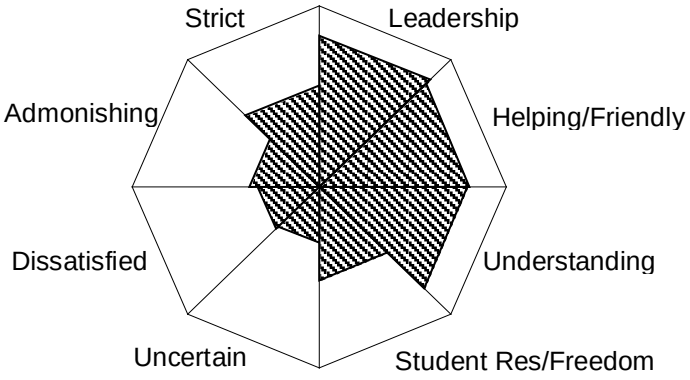


Figure 4.9. Profile – Student Actual Perception.

For professional development, teachers not only can compare their own perceptions with their ideals or the perceptions of their students (e.g. den Brok, et al., 2002), but they can also compare their own perceptions or that of their students with each of the different types and see with which typologies they fit best. Typologies have the advantage of being able to provide an instant picture of teaching against known groupings and summarise the learning environment in just one word, rather than in terms of several scales or many items. This makes them particularly practical and supportive of teacher self-reflection.

4.8 CHAPTER SUMMARY

Data from 279 students from Primary 5 Singapore GEP schools were collected and analysed to investigate the association of teacher interpersonal skills with student's cognitive and attitudinal outcomes. The Questionnaire on Teacher Interaction (QTI) and three scales adapted from the Test of Science Related Attitudes (TOSRA) were used forming 48-item and 30-item questionnaires, respectively. Students responded on a 5-point Likert scale. The internal consistency of QTI scales was analysed and found to be 0.69 to 0.88, indicating high internal consistency to be used with Primary 5 gifted students. Three attitude scales adapted from TOSRA were also validated for the same sample, indicating high consistency from 0.76 to 0.96. The reliability and validity analysis indicated that the instruments can be used with confidence with gifted students in Singapore.

Cognitive achievement was higher where the teachers were perceived to demonstrate more leadership, helping/friendly, understanding and allowing student responsibility/freedom behaviours and less dissatisfied and admonishing behaviours.
An examination of beta weights reveals that only two of the eight scales retained their significance. The Strict scale was positively associated and Dissatisfied scale was negatively associated with cognitive achievement of the students.

When associations between teacher-student interaction and attitudinal achievement were studied, it was found that the Leadership scale was positively and significantly associated with attitude towards scientific inquiry. *($p<0.05$)* The R^2

figure indicates that 3% of variance in students' attitude towards scientific inquiry can be attributed to their perception of teacher's interpersonal behaviour.

The beta weights presented in Table 4.8 suggest that students' enjoyment of science lesson was particularly evident when the students perceived higher levels of Leadership and Helping/Friendly behaviour in their teacher. Conversely, students who perceive their teachers as showing higher level of Admonishing behaviour have lower level of enjoyment of science lessons.

Gender-related differences in perceptions of gifted students in science classes were found to be statistically insignificant, suggesting that, for this sample, male and female students viewed their science teachers very similarly.

Students perceived their teachers more favourably than did the teachers themselves in the Dissatisfied, Admonishing and Strict scales and more favourably on the Leadership, Helping/ Friendly and Understanding scales. This study reports a tolerant/authoritative teacher behavioural pattern which is characterised by a pleasant well structured environment in which teacher has a good relationship with students. This perception forms the profile of GEP science teachers in Singapore. The next chapter presents qualitative results obtained from small group interviews with students from four classes.

CHAPTER FIVE

STUDENT INTERVIEWS

5.1 INTRODUCTION

This chapter presents the results from the interviews on teacher-student interactions and students' attitudes towards science lessons in Primary 5 gifted classrooms in Singapore. These data were obtained from interviews in an effort to validate and enhance the findings from the quantitative data. Twenty-two students from eleven classes in four schools were interviewed. These students were primarily grouped according to their schools.

When quantitative methods are combined with qualitative methods, they provide a more complete examination of classrooms and schools. In this study, some students were interviewed to obtain greater insight into their perceptions of their teachers, and classrooms were observed to determine what interactions were occurring. The findings from the classroom observations are elaborated in greater detail in the next chapter.

The QTI scales portray eight areas of teacher behaviour. Some examples of behaviours which described the QTI scales are as follows.

The Leadership scale describes a teacher's behaviour in relation to how he/she leads, organises, gives orders, sets tasks, determines procedure, structures the classroom situation, explains and holds attention in a classroom. The Helping/Friendly scale describes the teacher's behaviour in relation to he/she assists, shows interests, joins, exhibits friendly and confidently manners, can make a joke and trusts students. The Understanding scale is the extent to which the teacher shows he/she listens, emphasizes, shows confidence and understanding, accepts apologies, looks for ways to settle differences, is patient, and is open to students. The Student Responsibility/Freedom scale describes the teacher's behaviour in relation to how he/she gives opportunity for independent work, waits for the class to let off steam

and gives freedom and responsibility to students. The Uncertain scale describes the teacher's behaviour in relation to how he/she keeps a low profile, apologies, waits, keeps her/his temper and admits one is in the wrong. The Dissatisfied scale describes the teacher's behaviour in relation to how he/she waits for silence, considers pros and cons, keeps quiet and shows dissatisfaction to students. The Admonishing scale describes the teacher's behaviour in relation to how he/she gets angry, takes pupils to task, shows irritation and anger, forbids, corrects and punishes. The Strict scale describes the teacher's behaviour in relation to how he/she keeps reins tight, checks, judges, gets class silent, is strict, exacts norms and sets rules to students.

In a research study by Levy, Creton, and Wubbels (1993) where analysed data from studies in The Netherlands, the USA and Australia involving students being asked to use the QTI to rate their best and worst teachers, students rated their best teachers as being strong leaders and as friendly and understanding. The characteristics of the worst teachers were that they were more admonishing and dissatisfied.

It is noteworthy that the best teachers, according to students, are stronger leaders, more friendly and understanding, and less uncertain, dissatisfied and admonishing than teachers on average.

In one Australian study Fisher, Rickards, and Fraser (1996) found that after having completed the QTI and having had time to consider the results supplied to them, science teachers reported that they had been stimulated to reflect on their own teaching and verbal communication in the classroom. For example, one teacher concluded that she had become more aware of her students' need for clear communication and that this had become a focus for her in improving her classroom teaching.

5.2 PROFILE OF STUDENTS AND TEACHERS

When the results from the use of quantitative methods are combined with those obtained from qualitative methods, they provide a more complete examination of the classroom learning environment at the present. During the interview, students were asked to comment on aspects of their perception of their science teachers related to

the scales of the QTI. On average, each interview session conducted with two to six interviewees lasted approximately 35 minutes.

5.2.1 Students' Profile

Table 5.1 shows how each group is made up of students from different gifted classes in the same school (hence, under the same teacher). For example, (E1) represent students from class 1 of group E. As a result of class time-table constraint, students from one of the participating schools were spilt into two groups for interview.

Table 5.1

Distribution of Interviewees

Group	Number of classes	Number of students per class	Total number of students	Number of girls / boys
Group A	2	2	4	1 girl 3 boys
Group B	2	2	4	4 boys
Group C	3	1 to 3	6	2 girls 4 boys
Group D	1	2	2	1 girl 1 boy
Group E	3	2	6	3 girls 3 boys
Total	11	NA	22	7 girls 15 boys

In this chapter, section 5.3 presents the opinions of students based on their responses to interview questions about aspects of teacher interpersonal skills measured by the QTI. These results also provide additional qualitative data that support QTI validation for use in Singapore primary science classrooms. In addition to studying the responses to specific questions, the students' replies were investigated for teacher behaviour qualities described by the QTI scales and students' attitudes by TOSRA scales. Any occurrence of teacher behaviour qualities and student attitudes are coded by a number given in bracket [ ] which refers to the QTI scales when the respective behaviour is reflected in the interviewee's response.

Excerpts from the interviews were studied and coded against the QTI and Attitude scale items to identify any instances of traits displayed. Questions are also grouped to

validate specific scale means. Close reference to the derived scale mean provides for more in-depth analysis and verification.

These group interviews with students in a sub-sample of about 8% of the 279 (22 students) were an essential source of information to complement the statistics derived from the QTI. In the open-ended interview, the researcher asked the interviewees a series of questions, starting from general issues to make them feel at ease and also build up rapport with them.

The interviews also were used to check whether students have responded to questionnaire items on the basis intended. Listening to the audiotapes also proved fruitful, as it did provide certain information at times which had been missed during the recording of the observations.

The interviewees were also prompted with some selected QTI items during the interview. Every attempt has been made to reflect the spirit and tone of the comments accurately.

5.2.2 Teachers' Profile

Coincidentally, in this present study, all participating teachers are female with at least five years of science teaching experience in the GEP.

Table 5.2

Profile of GEP science teachers whose students were interviewed

No. of science teachers' classes involved	4
Gender	female - 4 male – 0
Years of teaching experience in the GEP	5 < years < 15
School	co-educational - 3 boys' school – 1

5.3 INTERVIEW QUESTIONS AND RESPONSES

Table 5.3 summarises the mean and standard deviation values of the QTI and Attitude scales obtained in Chapter 4, along with number codes [ ] assigned to each scale for easy referencing in the excerpts from the interviews.

Table 5.3

Scale Means and Standard Deviations for Science Students on the Eight Scales of the QTI and on the Attitude, Adoption and Enjoyment scales

Number Code	Scale	Mean	Standard Deviation
[1]	Leadership	4.17	0.62
[2]	Helping/ Friendly	4.02	0.81
[3]	Understanding	3.95	0.71
[4]	Student Responsibility / Freedom	2.60	0.72
[5]	Uncertain	1.56	0.48
[6]	Dissatisfied	1.65	0.63
[7]	Admonishing	1.84	0.65
[8]	Strict	2.82	0.71
[9]	Attitude to Scientific Inquiry	3.95	0.60
[10]	Adoption of Scientific Attitude	3.85	0.54
[11]	Enjoyment of science lesson	3.96	0.93

n = 279

5.3.1 The GEP Science Classroom

At the beginning of the interview, simple questions were posed to warm up the students to make them feel at ease. These questions were intended to solicit comments about science lessons in the gifted classrooms in general from the students' perspective.

Question 1

To help students settle in comfortably and get a feel about the science classroom.

	What is your science class like?
Group	Responses
Group A	*It is exciting, with group work and fun experiments.* [11] (A1) *We have journal writing – which is fun.* [11] (A2)
Group B	*It is fun and exciting.* [11] (B1) *It is full of experiments. Interactive and fun.* [11] (B2)
Group C	-
Group D	*We do experiments and go through concepts/facts for worksheet. The class is interesting, fun and noisy, but can be boring when we need to copy notes from the slides.* (D1)
Group E	*It depends on what's happening in class.* (E1) *When we or class discussion or experiment, it is fun.* (E2) *When we construct a mind map, it is also fun.* (E3) *When we copy notes, it is boring.* (E2)

Question 2

To help students settle in comfortably and get a feel about the science classroom. (Enjoyment of science lesson scale, mean = 3.96)

	Do you look forward to your science class?
Group	Responses
Group A	*Yes.*[11] (A1, A2)
Group B	*Sometimes, if the topic is interesting*. [11] *No.* *Yes.* [11] (B2) } (B1)
Group C	*Yes* [11] (C1,C2,C3)
Group D	*Sometimes yes, sometimes no. It also depends on the lesson before the science class. If it is interesting, we don't want it to end.* (D1)
Group E	*Generally yes.* [11] (E2) *Sometimes no, if we know it (the lesson) is copying notes.* (E2)

From their comments, it is apparent that students from the participating schools generally enjoy their science lessons. This is reflected in the relatively high scale mean of 3.96.

Question 3 was asked to identify the characteristics of a favourable science teacher, in the students' opinion. It was also neither judgmental nor intrusive, to maintain their comfort level. Responses to Questions 3 and 4 are not number coded, as they reflect hypothetical qualities in general.

Question 3

To help students settle in comfortably and get a feel about the science classroom.

	What do you think are the qualities of a good science teacher?
Group	Responses
Group A	*The teacher is gentle and patient, who is passionate and enthusiastic about teaching science.* (A1) *The teacher must know her facts, is helpful, kind, cheerful and has sense of humour.* (A2)
Group B	*The teacher must be caring, approachable, helpful, patient, understanding and knowledgeable on interesting facts of the topics taught. The students should have more experiments and computer-lab based lessons.* (B1) *The teacher must be very knowledgeable (about science) and willing to go the extra mile for students. To include field trips/ excursions in lessons.* (B2)
Group C	*The teacher is able to explain (concepts), has sense of humour and must let you have hands-on (activities).* (C1) *The teacher must be able to get everybody's attention, plans interesting lessons and can give you general knowledge.* (C2)
Group D	*The teacher must be creative with new ideas. He/she must be interesting and patient. Neither too fierce nor too lenient and must enforce some form of discipline.* (D1)
Group E	*The teacher must be patient, willing to accept new ideas, creative and must be able to make the lesson interesting.* (E1) *The teacher must be flexible, clear and fluent in teaching, has organised speech and teach outside (beyond) interesting facts.* (E2) *The teacher must allow discussion, knowledgeable, be able to answer questions clearly and conducts hands-on activities.* (E3)

The students cited: helpful, kind, knowledgeable, able to capture attention, patient and conducts experiments as desirable traits of a good science teacher.

Question 4

To help students settle in comfortably and get a feel about the science classroom.

	What do you think are the qualities of a 'not-so-good' science teacher?
Group	Responses
Group A	*(Teacher is) boring, unhelpful; hates teaching science and simply provide reading materials for students to read up themselves. No experiments conducted.* (A1) *A teacher who scolds and advocates route learning.* (A2) This group of students also pointed out the amount/ type of activities carried out in class actually depended on the class dynamics. If students are noisy and uncooperative, it is very difficult for the teacher to conduct activities. Hence didactic learning will take place, which in turn bores the students who create more problems. This amounts to a vicious cycle. Students show awareness that their behaviour in class indirectly contributes to the type of lessons they receive.
Group B	*A teacher who likes to scold students. Not approachable and understanding. Tells students to read up on their own. Only dictate and set worksheet assignments. Does not conduct interesting activities. The teacher scolds and embarrasses you in front of the whole class.* (B1) *The teacher vents anger on students and only does the basic things he/she needs to do. Just keeps talking. (didactic learning) Very strict, not encouraging at all.* (B2)
Group C	*The teacher doesn't answer your questions and doesn't explain things well. There are only theory lessons, no practical (lessons). Gives uninteresting lessons and has no sense of humour.* (C1) *Teacher makes you learn by heart and cannot capture students' attention.* (C2) *The teacher doesn't go through things (lesson concepts).* (C3)
Group D	*The teacher is boring with no sense of humour. Monotonous lesson delivery. Fierce. Gives big scolding for small mistakes and just stick to the syllabus because of time constraint. (Students want to be in touch with current issues and happenings).* (D1)
Group E	*(Teacher is) boring, impatient and not knowledgeable.* (E1) *There is no (science) experiments. Teacher only uses textbook and workbook. Teacher does not prepare for lesson or doesn't explain because of 'no time'.* (E2) *The teacher doesn't expose the students to the topic and doesn't explain (how to do) the worksheet.* (E3)

In contrast, students defined a teacher who is unapproachable, always scolding, boring, does not experiments as some of the negative characteristics in a science teacher. The interviewees were articulate and descriptive of what they like and do not like.

The next two questions provide more insights into the science teachers' interpersonal behaviour. As can be seen in the example of comments in response to Question 5, generally, the teachers have been perceived as fair, confident and assertive. In general, the students appear to be quite happy about their science lessons.

Question 5

General comments about teacher's classroom behaviour.

	Describe your teacher's classroom behaviour. What kind of person is your teacher in the classroom?
Group	Responses
Group A	*As a leader, she is straight forward and she knows what she wants.* [1] (A1) *Sometimes, we can influence her* [4] *on the good things. Sometimes she can be jokingly sarcastic.* (A2) *Generally, we are very relaxed and happy* [11] *during science class.* (A1, A2)
Group B	*My teacher is fun* [2] *to be with.* (B1) *Sometimes she is laughing; sometimes she pulls a long face. She is disappointed/ sad if students have poor marks.* [8] (B1) *No expression – I don't know what she is thinking. She is angry when students don't put in effort.* (B2)
Group C	*The teacher rushes the lesson to complete correction, if necessary.* (C1) *The teacher is relaxed and patient.*[3] (C2) *The teacher is accommodating* [3] *to your learning needs.* (C3)
Group D	*The teacher is cheerful most of the time, but is fierce if the class is noisy or someone misbehaves despite repeated warnings. The teacher also allows the students to interact and ask her questions.* (D1)
Group E	*The teacher is quite fair, stern and confident.*[1] (E1) *The teacher is humorous.* [2] (E2) *The teacher is quite stern.* [8] (E3)

5.3.2 Construct Validation of the QTI Scales

After a round of questions which explored the gifted science classroom, the interviewees were prompted about their relationship with their own science teachers. By looking at the frequency of occurrences of behaviour traits corresponding to the QTI scales, it is observed that behaviours from the Leadership and Helping/Friendly scales appear most frequently in the teachers' daily interaction with students. This

agrees with the high mean values presented in Table 5.3. (Leadership, mean = 4.19; Helping/Friendly, mean = 4.02)

Question 6

To gather more insights into the science teacher's interaction with the students and validate Uncertain (mean = 1.56).

	What are the good things and bad things about your relationship that you have with your science teacher?
Group	Responses
Group A	*She has most of the qualities (of an ideal teacher).* (A1, A2)
Group B	*She is interesting, with a sense of humour. She helps you as much as possible.* [12] (B1) *She goes the extra mile* [1], *spending her free time and money for us. She pays for materials (for projects)* (B2) *The teacher is very strict. She scolds us when we don't remember things (lessons) that she has repeated in class. Sometimes it is stressful* [7] *being in her class.* (B2)
Group C	*I don't have very good relationship with the science teacher. I don't like her. She ignores you when you ask questions and she makes us copy all the long answers for correction. She also holds you back from recess for learning. This teacher also wants you to ask questions, but you have to find your own answers. She spends half the lesson time lecturing us.* [7](C1, C2) *The teacher will tell interesting stories from her life experiences.* (C3)
Group D	*I can talk to my teacher freely and she laughs with me. She doesn't mind 'sick' stuff, most teachers don't accept 'sick' stuff. She is an approachable teacher.*[2] *She doesn't want anybody to disrupt her lesson. If you talk too much, you get 5 minutes time out (stand at one corner) and 2 points deducted from your group. She raises her voice almost every day (and yells) when the class is noisy.* [7] (D1)
Group E	*The teacher makes the lesson interesting. She is approachable* [2] *and she has a 'point system' to motivate students (to do better). She prepares powerpoint slides with 'fill in the blanks' to keep students focused and on task.* [1] (E1, E2, E3) *She is able to control* [1] *the class very well, but if students are too noisy, she shouts very loudly. If a student is still talking after warning, he/she is sent to stand at one corner.* [8] (E1, E2, E3)

At the same time, the interviewees did not express situations in Question 6 relating to Uncertain scale behaviours. This concurs with the quantitative result (in Table 5.3)

which reflected that Uncertain scale mean of 1.56 was the lowest in all the QTI scales.

In a further effort to look for evidence of leadership qualities (Leadership scale, mean = 4.17), understanding, uncertain and admonishing behaviours (Understanding scale, mean = 3.95, Uncertain scale, mean = 1.56, Admonishing scale, mean = 1.84), students were asked if their teacher led, organized and structured the classroom situation and whether she listened with interest, empathised, showed confidence and understanding and was open with students.

Additional prompts included whether the teacher behaved in an uncertain manner or kept a low profile, whether the teacher got angry, expressed irritation and anger, forbade and punished.

Question 7

To validate Leadership scale (mean = 4.17)

	What type of leadership roles does your teacher take?
Group	Responses
Group A	*My teacher is firm* [1] *with rude students.* (A1) *When we are well-behaved, we get longer time in the computer lab.* [4] (A2)
Group B	*The teacher will sacrifice time and money and will guide us through our work. She makes you more conscientious.* (B1) *The teacher gives you responsibilities* [1] *and helps you realise your dreams.* [4] (B2)
Group C	*The teacher wants to inspire us to teach, but she is not inspiring. She is experienced, and strict.* [8] (C2)
Group D	*She knows the subject (quite factual) and so she is quite firm.*[1] (D1)
Group E	*The teacher is quite firm and confident* [1]. *She knows what's going on and she knows what to do. She manages to win the difficult pupils over.* (E1, E2, E3)

The Leadership scale yielded the highest mean among all QTI scales in the present study. This showed that gifted students perceived and regarded their science teachers as capable leaders who led them in their quest for knowledge. Responses to Question 7 validated the high Leadership mean score where many students described their teachers as 'firm'.

Question 8

To find out how much student responsibilities the students perceive themselves to receive.

	What type of leadership roles does your teacher allow you to take?
Group	Responses
Group A	*The teacher picks anybody randomly to run errands. We are happy as this is fair* [1] *since everybody stands a chance. Nobody has a specific role, but usually the better behaved students are tasked.* (A1, A2)
Group B	*The teacher appoints* [4] *group leaders and rotates worksheets collectors*. (B1, B2)
Group C	*She lets you take leadership role* [4]. (C2)
Group D	*Only the Form Teacher selects leaders, but the science teacher lets everyone to have a chance* [2] *to do something*. (D1)
Group E	*The teacher appoints different people to do different tasks for each activity. She also elects the science monitor*. (E1, E2, E3)

Question 9

To validate Helping/Friendly scale (mean = 4.02)

	Would you say that your teacher is friendly or helpful? Explain why you think this.
Group	Responses
Group A	*The teacher is both friendly and helpful. They are interdependent.* [2] (A1, A2)
Group B	*The teacher is more helpful. When we get low test marks, she makes us do proper corrections for filing (daily work component) to get higher marks. She constantly reminds us to be neater and produce higher quality answers.*[2] (B2)
Group C	mixed responses: *More friendly – She smiles and chats with the class.* [2] (C1) *More helpful – when we encounter problems with school work, she will give hints, but she doesn't spoon-feed us.* [2] (C2)
Group D	*The teacher is friendlier to better behaved students. She chats with students.* [2] (D1)
Group E	*She is willing to help. If there is any serious problem, she will try to solve* [1] *immediately.* (E1) *She is friendly when she smiles. Otherwise she is more helpful.* [2] (E2) *She is helpful most of the time, but she does not speak in a lenient manner (sometimes).* (E3)

A relatively high Helping/ Friendly scale mean of 4.02 was obtained in Chapter 4. Question 9 helps to provide qualitative support and validity to this value by asking students to elaborate about their teachers' friendly or helpful approach.

It was observed that other qualities, for example, leadership behaviour was also revealed from the students' responses.

Question 10

To validate Strict scale (mean = 2.82) and Student Responsibility/Freedom scale (mean = 2.62)

	Would you say your teacher is more strict or more likely to give you more responsibilities and privileges? Explain why you feel this way.
Group	Responses
Group A	*The teacher is only strict at times. She usually rewards good students (behaviour/results) with computer lab time.* [1] (A1, A2)
Group B	Mixed responses. *She gives more responsibilities and privileges. Through team work, she trains you to be more responsible by appointing you as a leader.* [4] (B1) *She is strict. She has high expectations and wants pupils to take (down) notes*. (B2)
Group C	*This teacher is very strict* [8]. *One little whisper and you can land up standing outside (the classroom). Sometimes the teacher insists on doing things her way*. [8] (C1, C2, C3)
Group D	*She gives more responsibilities and privileges. There are rewards if we do well. E.g. the group with the highest points wins a lolly for every member.* (D1)
Group E	*She is more likely to give responsibilities. She gives responsibilities even to naughty people (students). She is not biased.* [1] (E1, E2, E3)

To look for evidence of giving students freedom, (Student Responsibility/Freedom, mean = 2.60), helpful or friendly disposition (Helping/Friendly scale, mean = 4.02) or strict (Strict Scale, mean = 2.82)

Students were asked if their teacher assigned responsibilities and adopted students' suggestions. The questions explored if the teacher was friendly and helpful; or displayed the Strict scale characteristics by conducting checks, maintained silence and strictly enforced the rules.

Every student in GEP will be given a chance to perform some leadership roles in every academic year. The responsibilities range from: group leader, monitor, treasurer, class librarian, whiteboard monitor, absentees' box monitor etc and other administrative duties.

By comparing the QTI Strict scale (mean = 2.82) and Student Responsibility/Freedom scale (mean = 2.62), Singapore GEP teachers were perceived to be strict rather than giving students responsibilities and freedom. The close mean values are also validated by mixed responses to Question 10.

The GEP puts a lot of emphasis on students' learning attitude and daily work consistencies. Teachers are strict about inculcating good work habits that promote effective learning.

Question 11

To validate Understanding scale (mean = 3.95) and Strict scale (mean = 2.82)

	Would you say your teacher helps students behave more by making strict rules or by encouraging students to do what is right? Why do you think this way?
Group	Responses
Group A	Mixed responses. *Strict.* (1 student) *Encouraging. The teacher gives students freedom.* [4] (3 students)
Group B	*Encourage students to do what is right. The teacher doesn't really scold (us), but more into counseling. If the teacher is too strict, the students would be defiant and do not want to do more.* [3] (B1, B2)
Group C	*She makes strict rules.* (C1, C2,C3)
Group D	*Encourage students to do what is right. She talks to students and gives warning first. If failed, then she yells.* (D1)
Group E	S*he has strict rules. She has a punishment system – e.g. when someone is talking when she is teaching, she goes slower and softer and make the person feel self-conscious.* [8] (E2)

Results presented in Chapter 4 showed students perceived their teachers as relatively stricter than giving students responsibilities and freedom, also teachers were perceived as more understanding than strict. This was also revealed and supported by

responses to Question 11. The teachers were usually encouraging towards students and some basic disciplinary system about rules and regulations was in place for every class. The students did not favour strict rules or being embarrassed in class. If the teacher came down hard on them, they defied more; they reacted better to softer approaches. Generally, students perceived their teachers as being firm with them. With a common understanding of the class rules, the students understood that teachers were right to discipline them if rules were violated.

Question 12

To compare between cooperational and oppositional behaviours and validate Helpful (mean =4.02), Understanding (mean =3.95) scales and Admonishing (mean = 1.65), Dissatisfied (mean = 1.84) scales.

	Explain your teacher's use of competition and cooperation in the classroom. Which does the teacher use the most?
Group	Responses
Group A	*She concentrates mainly on cooperation, with occasional competition to spur you on.* (A1, A2)
Group B	*Cooperation. She only compares class and individual highest, not lowest. She encourages us.* (B1) *My teacher never compares marks between two individuals. She cares more about learning and encourages cooperation to achieve more.* [2] (B2)
Group C	*Competition. My teacher is competitive and is afraid to lose out.* (C1, C2)
Group D	*Cooperation. It is students who are keener to compete with one another. The teacher never compares between classes or reveal who has the lowest score.* (D1)
Group E	*She encourages cooperation especially in group work and class discussion. There is also friendly competition – just to see who (can) do well.* (E1, E2,E3)

Based on the Leary Model, responses to Question 12 agreed with the mean values from Table 5.3 that oppositional behaviours depicted by Admonishing and Dissatisfied scales were less than cooperational behaviours depicted by Helping/Friendly and Understanding scales. To find out students' perception of their teacher's level of satisfaction (Dissatisfied scale mean = 1.65), they recalled whether

they saw their teachers as expressing dissatisfaction, looking unhappy, criticising and waiting for silence.

Question 13

To find out how students perceive their teacher's satisfaction in class and validate the Dissatisfied scale (mean = 1.65)

	When considering your teacher's action in class, would you say that she is satisfied or dissatisfied being a teacher? What makes you say this?
Group	Responses
Group A	*Satisfied. She is smiling most of the time.* (A1, A2)
Group B	*Dissatisfied. She said we are the worst batch she has ever taught and she told us to pull up our socks.* [6] (B1, B2)
Group C	Mixed responses: *She is generally satisfied. My teacher takes her job seriously.* *She doesn't smile very often.*
Group D	*Satisfied. She doesn't complain and looks happy. Most of the time, she is cheerful and smiling.* (D1)
Group E	*My teacher looks satisfied. She is jovial*. (E2)

Most interviewees indicated that most teachers were not dissatisfied and hence validated the low scale mean of 1.65.

Past literature as well as the previous chapter of this present study showed that positive teacher behaviours described by the QTI items were used to improve students' cognitive achievements. This section looks for further support for the association between QTI scales and cognitive achievements.

Question 14

To explore the associations of teacher behavior and students' cognitive outcomes.

	What kind of practices does your teacher use in class to make you learn best? Explain.
Group	Responses
Group A	*We do experiments and research.* (A1, A2)
Group B	*We have hands-on experiments.*[1] *The teacher talks* [3] *to us about (right) behaviour, she does not stick to textbook, but does more experiment and explain.* (B1) *We have experiential learning. We observe experimental setups and draw our own conclusions. She also talk to us on how to behave in a certain (correct) manner* . (B2)
Group C	*We have closer interactions.* (C1) *We do note-taking. The teacher also gives handouts.* (C2)
Group D	*The teacher tells jokes. She prepares 'fill-in-the-blank type' of powerpoint slides so that students have to follow the lesson to take notes and have no chance to switch off.* (D1)
Group E	*The teacher uses mind maps.* (E1) *There are mini quizzes, fill-in-the-blank type powerpoint slides, videos, and we learn from one another as well.* (E2) *We do lots of experiments.* (E3)

The researcher was looking for qualitative support (if any) for the correlation between Strict scale and test marks presented in Chapter 4. It was noted from the interviewees' responses that the teachers played an important role in setting tasks and was in full control of the classroom situation. Students learn best when there is perceived leadership, with properly planned lessons and structured delivery, and at the same time provided ample room for student self-discovery. Examples of such lessons include experiential learning and hands-on experiment, where there are specific aims and direction with clear experimental procedures. Interviewees had expressed explicitly that conducting experiments help them learn best in cognitive outcomes.

5.3.3 Student Attitudes

This section reports on students' attitude towards learning of science and scientific inquiry (Adoption of Science Attitude scale, mean = 3.85; Attitude to Scientific Inquiry scale, mean = 3.95)

Question 15

To find out about students' attitude towards science lessons.

	Would you say that your attitude towards science has stayed the same, improved or declined as a result of being in your science class? Can you describe what factors have contributed to this change?
Group	Responses
Group A	Mixed responses: *Improved. Nice teacher and classmates. The teacher makes the topics interesting and has interesting activities this year. She is fair and not biased or rude.* [3] *Same.*
Group B	*Improved. The lessons are fun* [10] *as they are no longer 'textbook' lessons. We get to do background research* [11] *in our worksheets. There are helpful friends and our teacher is encouraging, caring and helpful.* [2] (B1, B2)
Group C	Mixed responses: *Same.* *Improved. Syllabus is more interesting* [10] *and there are more challenging things to learn.* *Declined. My previous teacher was more cheerful and looked younger.*
Group D	Mixed responses: *Same. Science is boring with a lot of facts to remember. We must note how to phrase the answers well. The subject is easy, just tiring and stressful to cramp everything before (the) exams.*[11] (D1) *Improved. The class is interesting and I want to learn more.* (D1)
Group E	*It is the same, because the amount of science content is roughly the same. It depends on my own self-interest, not so much on the teacher.* (E1) *Improved. My previous teacher was monotonous. She also kept repeating herself. My current teacher's voice is clearer in the way she teaches. The (type of) teacher will affect my grades.* [11] (E2) *Improved. My science teacher last year was disorganized and she had missing worksheets!* (E3)

Question 16a and 16b

	a) Would you like science less if you did not score well repeatedly?
Group	Responses
Group A	-
Group B	*No*
Group C	-
Group D	*Sometimes. When the boys don't cooperate, going through things (test items) can be very boring.* (D1) *No.* (D1)
Group E	*It depends on the topic taught.* (E1) *Sometimes yes.* (E2) *It depends on the teacher, marks and topic.* (E3)
	b) Is your liking for science marks related?
Group A	-
Group B	*No* – 4 students
Group C	-
Group D	*Sometimes* – 1 student *No* – 1 student
Group E	*Yes* – 4 students *No* – 2 students

Interviewees generally adopted a good learning attitude towards science and were keen to improve themselves in terms of examination marks. This supported the high attitude scales means reported in Table 5.3. The students' comments revealed that their interest in science and attention span during lessons were largely influenced by experimental activities and engaging teachers. They could be demoralized if they failed to score well repeatedly. However, some students indicated that they were self-driven to do well academically, and thought that their teachers did not play a vital role in their academic interest. Students hope for a conducive learning environment, where their classmates would not be disruptive during lessons. This would affect their focus and attitude towards learning science.

5.3.4 Future Research in Teacher Interpersonal Behaviour

In order to find out what gifted students prefer to have in their daily science curriculum, they were prompted with additional questions that might pave the way for further research on this topic.

Question 17

What gifted students desire in their science class for future research directions.

	What would your ideal science class be?
Group	Responses
Group A	*To have more computer sessions where we can do online research. To be able to create powerpoint slides for class presentation. Experiments and hands-on activities.* (A1, A2)
Group B	*The classroom is peaceful, not chaotic. Systematic lessons. To have more IT lessons and more hands-on activities.* (B1) *Where we have group work and we learn more and also learn properly. No embarrassment because of low marks. Lots of experiments to get first-hand experience.* (B2)
Group C	*A good, conducive (learning) environment to do hands-on activities, e.g. a fern garden.* (C1) *The teacher is lenient, and we have more time for homework. No embarrassment (in class). The teacher just cares about your science concepts, not handwriting.* (C2) *The students use games to play and learn at the same time.* (C3)
Group D	*There are lots of challenging experiments, nice interactive classroom decoration. The teacher is humorous and nice and without disobedient /disruptive students in class.* (D1)
Group E	*There are lots of discussions and fun facts.* (E1) *Where there are games, more classroom activities and less homework. There is also no disruptive people (student).* (E2) *The teacher gives us hands-on activities.* (E3)

Question 18

	What do you think the students would be doing in this ideal science class?
Group	Responses
Group A	*Everybody would be engaged.* (A1, A2)
Group B	*Students would be highly attentive, and wants to learn more. They work as team, getting things done efficiently. They also respect the teacher.* (B1) *The students are engaged in experiments on their own. The teacher walks around to supervise, making sure that everybody is on task and no one is sleeping.* (B2)
Group C	*Doing experiments, having debate sessions or playing games.* (C1, C2, C3)
Group D	*Students will be interacting, playing some educational games or doing some scientific experiments.* (D1)
Group E	*Students will be learning and no one is talking nonsense / irrelevantly.* (E1) *Students will be viewing exhibits.* (E2) *Students will have the freedom to talk.* (E3)

The comments in response to Questions 17 and 18 revealed that gifted students look forward to structured and organized environments for learning. They appreciate some freedom in their learning process, as they might exhibit multiple intelligences, and are not confined to limited ways of learning. They yearned for challenging stimuli and took learning seriously. These students welcomed both group and independent learning and wanted to see themselves to be meaningfully occupied in class, when lessons were on-going. Some students highlighted a preference for cooperative classmates and most of them hope for experimental and interactive activities and less homework.

5.4 CHAPTER SUMMARY

Interviews and observations were employed to gather qualitative data to complement the results obtained with the QTI. The students provided valuable insights into the gifted learning environment and its associations by giving their perceptions of their science teachers.

Accordingly, the students' account from the interviews substantiated the validity of the QTI, as reflected by the item means and standard deviations in Table 5. 3.

These invaluable verbal accounts provide substantial support to the validity of the QTI, and teachers are able to use the QTI to address differences of teacher behaviours with confidence.

In a broad overview, students across all six schools generally enjoyed hands-on activities and laboratory lessons as compared to theory lessons. It was generally felt that teachers tend to favour the better-behaved, more successful students but kept their preference discreet. There is no evidence of any discrepant treatment of students from different socio-economic and cultural backgrounds.

Most of the students have good relationships with their teachers and perceive them as good leaders, helping, kind and confident. The teachers are very seldom perceived as admonishing and dissatisfied, though strict. Students state that they appreciate if their teachers set up some rules to provide structure and boundaries.

CHAPTER SIX

CLASSROOM OBSERVATIONS

6.1 INTRODUCTION

Three of the GEP schools in Singapore participated in lesson observations in this research study. It was a privilege as these schools have been producing top national scholars in the Primary School Leaving Examination (PSLE) in recent years. A computer lab class lesson and two classroom lessons were observed for 60 minutes each (double-period lesson). The observations that were made and their interpretation are presented in this chapter. For each of the three classroom lessons observed, the researcher kept hand-written field-note documentation of essential events, teachers' and students' behaviour and conversations and the phases of the lessons. The lessons were videotaped and the tapes were used to clarify in-class observations to substantiate the field-notes. After obtaining some insights into the three gifted classrooms, examples of teacher behaviours depicted by the QTI scales are illustrated Section 6.3.

6.2 ACCOUNT OF CLASSROOM OBSERVATION

The section below describes the classroom scenarios. According to the P5 GEP science syllabus, the prescribed topic at the time of observation in Semester One of the primary 5 academic year was *Plant and Animal Reproduction*.

6.2.1 School X – Classroom Lesson

This was a lesson on *Family Trees* where skills in creating a family tree were taught. These included drawing the lines of descent from parents and information such as year of birth and gender.

The teacher had prepared some ICT for the lesson, but the computer failed and she was very disappointed at not being able to show her slides and pictures and online

resources. There was no technical help available, so she had to forgo the ICT part and carry on with her lesson. There was no time to lose. She did not move the class to the computer laboratory as the additional class movement would have consumed more time.

First, the teacher started with a recap of the previous lesson on Family Trees. She solicited responses from the students, actively throwing questions at the class. These students could not wait to answer the teacher's questions and did not hold back in giving their answers. A few students tended to interrupt the teacher, some other students were seen engaging in their own private conversation. Not everyone was attentive.

At the back of the classroom, the researcher could see that the students were noisy during the lesson when the teacher was trying to explain the topic. One boy even cracked a joke with the teacher and behaved disrespectfully.

To the researcher's astonishment, the students were not in awe of the video equipment capturing their very behaviour in the classroom. In a nutshell, some students were busily talking to each other, some volunteered answers, some were passive listeners. This class had colourful characters who created an active class dynamic.

After the initial teaching, students were given groupwork where they formed into groups of fives. They were required to craft a hypothetical family tree and design questions based on the family tree diagram. Active group discussions followed, with the teacher going around and checking the students' work.

As the time passed, the teacher went to each group at least twice during her rounds to clarify any ambiguity and improve on the students' work. There was insufficient time for any group to present their family tree questions to the class. It was intended that the students' discussion would resume in the next science lesson, after which, they would pose their derived questions to their peers for feedback and evaluation.

6.2.2 School Y – Computer Lab

This was an enrichment lesson on the topic *Reproduction in Animals.*
Background information to the activity was given to the students as follows:

> *A brief history of Russia- Last tsar (king) of Russia – Tsar Nicholas II was abdicated after a mutiny broke up. All his family members together with the accompanying servants, doctor and a nurse were thought to be massacred in 1918.*
> *Unsolved mystery – A woman, Anna Anderson, claimed to be the youngest daughter (Anastasia) of Tsar Nicholas and his wife, Tsarina Alexandra in 1920. This started the mystery. Was Anna Anderson Anastasia Nicholaevna? At that point in time, only simple techniques were used in making any possible deductions. These included the use of comparing physical appearances, handwriting analysis and ear test. All these, together with Anna Anderson meeting up with Anastasia's maternal aunt and involving three extensive court cases, she still could not prove her real identity over a sixty-two year period. It was only much later, in 1994, 10 years after her death, when an analysis of her DNA was sequence enabled the truth to be found.*

In this activity, the pupils went through the history and deduced sequentially how the mystery of Anna Anderson was solved. It gave students an opportunity to do hands-on activity to experience what it is like to work as a scientist to analyse given data and make inferences. They were also able to work on real-life examples and experience themselves how useful DNA sequencing is in identifying an individual.
The teacher started the lesson by introducing the Russian lineage and distributed background information articles about Anastasia.

Each student was given a CD to work on independently. They attempted the assignment at their own pace. The students were excited and worked individually on their assigned laptop terminals. This was an IT-based lesson and the students were highly enthusiastic. Most of them preferred to work on their own. Even when one

student was facing some difficulty and was slower than his peers, he navigated on, determined to make new discoveries himself.

The class teacher adopted the role of a facilitator, only rendering help to those who needed it. Otherwise, the students and she were happy about the independent work time.

Every student was engaged, with the teacher walking around, giving occasional hints or praise. The lesson was well structured, all students were given specific instructions in proper scaffolding, and they looked to their teacher for directions.

The individual computer work took about 35 minutes. They were then given a worksheet to complete as classwork. The teacher did not reveal the final answer and students were encouraged to persevere in their pursuit of the answer.

6.2.3 School Z – Classroom Lesson

This lesson was based on the topic *Germination*, present in a section of *Plant Reproduction.* It came from the Selected Enrichment Package on Plant Reproduction provided by the Singapore Gifted Education Branch. In this lesson, students were given differentiated worksheets during class according to their prior knowledge. All primary 5 GEP students sat for a diagnostic test before commencement of the *Plant Reproduction* Chapter to provide the basis for differentiation.

The teacher began by showing a five-minute online animated video *Jack and the Bean Stalk* as an introduction to the lesson. Though this fairytale was nothing new to the children, the students were attentive and followed the video closely.

After playing the entire video clip, the teacher posed a few questions, and discussed with the class what was scientifically wrong with the cartoon. The students were enthusiastic in volunteering answers, which the teacher recorded on the whiteboard.

Very soon, all the unrealistic situations in the cartoon were mentioned by the students, without much help be the teacher. Then the teacher proceeded with her

instructional objective of making students understand seed germination. Students explored the factors required for germination. Some had prior knowledge, while a few were thinking about this for the first time.

Finally, the students were divided into groups to discuss all the factors necessary for seed germination. They were tasked to plan an experiment to find out what factors were required for successful germination. In this activity, students had to make use of their prior experimental design skills of setting up a fair test and identifying independent and dependent variables. The group discussions took about 30 minutes (1 period) and the teacher went to each group to monitor their progress. She queried some students' ideas, gave feedback and prompted some to lead them to think further. Overall, the students were actively discussing about the experimental design and were keen to seek their teacher's opinion on their ideas.

Before the lesson ended, the teacher encouraged the students to do their own research should they have any doubts regarding the assignment. They were allowed to bring home their worksheet for completion over the weekend.

6.3 TEACHERS' BEHAVIOUR IN CLASS

During each classroom observation, the researcher noted how the class teacher communicated and interacted with the students. The teachers' verbal and non-verbal behavioural exchanges with the students throughout the three lessons were recorded in the forms of video footages and field notes. The following sections cite instances of teacher behaviour listed according to the eight scales of QTI. Examples of the teachers exhibiting the QTI scale characteristics in the schools are elaborated in each section below.

6.3.1 Leadership

School X

On the day of the lesson observation, the computer unexpectedly failed to start up and marred the teacher's ICT lesson on the Interactive Whiteboard. Though disappointed, she was quick to remodel her lesson, wasting no precious curriculum

time. She gathered the students and recapped on the previous lesson on Family Trees. Transiting smoothly from simple recall-type questions to higher-order ones, she solicited responses from the class. Though the beginning part looked teacher-centred, she was able to organise and structure the learning. This teacher had strong subject knowledge and did not falter when one student asked suddenly, "*What if somebody is divorced, what happens to the line* [in the family tree]?" At this moment, another student shouted "*Dotted*". The teacher agreed, praised the quick answer and added, "*If they remarry,* [it] *will have another line*".

School Y

This enrichment activity was a challenging and captivating activity on the topic *Reproduction in Animals*. It was carefully crafted and well-delivered. The teacher held every student's attention throughout the lesson. Hand-outs were distributed at stages, not all at once, to build up the flow and continuity of information dispensed. After each piece was read by the students, the teacher asked questions to check their comprehension. She set tasks in a very systematic way, which students attempted at their own pace. Task expectation was explained very clearly and confidently and students were highly enthusiastic and listened actively. This is a very experienced teacher, students showed respect and listened to her. Simple instructions like "*Write your name on the worksheet*" were obeyed instantly.

The teacher distributed numbered CDs to the students, according to their register number. This process was highly organised and it was evident who had/ had not collected their CD.

School Z

The lesson was well-planned. The teacher started with a cartoon based on the familiar fairytale *Jack and the Beanstalk* as tuning-in and captured students' attention. All the students could relate to and appreciate this story. In her lesson, she was able connect the fairytale with science by making students identify "*What is in the cartoon that will not happen in real life*". The students' responses were recorded on the white board for easy reference. These students came with prior knowledge about seed germination, and the teacher used Socratic questioning techniques to draw answers from them.

She gave clear instructions about work methods to her students,

> *Boys and girls, keep focussed. Watch your time, you've got 20 minutes to work and you can discuss and your contribution.*

When the students came to a standstill in their group discussions, the teacher facilitated by asking leading questions, offer more perspectives and encouraged them to think deeper.

6.3.2 Helping/Friendly

School X

The teacher was asking for volunteers to mark out members on the family tree by shading, but one student put a cross instead. The class giggled, but she good-naturedly joked, "*never mind, some people shade differently*".

School Y

The teacher went around the computer lab checking on and helping the slower students. Ample time was given for self navigation.

The teacher injected some humour, "*Look up, pens down. p – e – n- s.*" when she wanted the students' attention when they were busy typing away on the laptops to explain further. Some boys giggled, and immediately everybody looked up. Students were cognitively engaged and enjoyed the lesson. The researcher could observe good rapport between the teacher and students. In one instance, she was talking to one student, the student said something, and the teacher 'hammered' his head with her notes affectionately; both chuckled.

School Z

This teacher was the most smiling one of all three classes observed. In the second half of the lesson where the students were having group discussions, the teacher went to every group to check on their experimental design. A student, who was suddenly conscious of the filming, covered his face shyly. She patted his head, laughing, "*No, it is okay, you're very handsome!*" He blushed and protested, "*No, I'm not!*"

She gave most help and comments to the group which had the most difficult experimental variable to work on – to plan an experiment to find out if oxygen was needed for germination. They had no idea how to remove oxygen in the test setup and the teacher guided by hinting that "*a chemical that absorbs oxygen*".

6.3.3 Understanding

School X

This class had more than two active students who needed constant reminders from the teacher to stop talking and focus on the lesson. She was very patient with the noisy ones, though some of them could be attention-seeking and deliberately gave irrelevant or funny comments. A handful of more vocal students repeatedly interrupted her lesson despite reminders like, *"Don't shout your answers*". Watching from the back, the researcher could sense that the control of the class was an energy-sapping situation for her.

School Y

The teacher was patient. During her rounds to check students' progress, she left the high-ability ones entirely alone. She knew they could be trusted to work independently. The lesson was well-paced such that students were allowed to explore at their own pace. There was no rush to quickly complete. The teacher constantly checked the level of progress by using a show of hands. The slower ones continued working, where the faster ones were gathered in front (computer lab) to brief them on finding advance information, as enrichment. It showed a good juggle of differentiated teaching.

School Z

During the beginning of the lesson, there was a commotion along the corridor and the students were obviously distracted. The teacher waited for the students to settle down before continuing with her lesson.

When doing her rounds of group monitoring, the teacher stood at the side, patiently listened to what the members had to say before adding her input. She did not interrupt the students, waiting and only giving suggestions when the students came to

a halt. She clarified and summarised their points of discussion and complimented the good ideas. The teacher also corrected their concept of independent and dependent variables. Two members in the group wanted to include a control setup in their experimental design, and the teacher sought opinions from the rest, asking, "*Do you agree?*" She encouraged the students to share their views among themselves and decide on the setups.

6.3.4 Student Responsibility/Freedom

School X

The students were noisy during the entire class discussion time because many students wanted to participate at the same time. The students were given the liberty to comment freely. They were relaxed and comfortable, and there was no fear of being sanctioned. However, some students really needed to raise their sense of self-awareness. The teacher was interrupted so often that the discussion was barely fruitful.

School Y

Thanks to the small class size, this lesson was designed giving opportunity for independent work. Each student had access to the interactive material from his/her computer. Everybody cooperated fully, even the lagging students did not hitch on to their friends for faster answers. Everyone wanted to find out their own answer.

School Z

In the group activity to construct an experimental design for three different aims, students were given a chance to choose which aim (hence the changed variable) they wanted to work on.

When the discussion in a group had constructively begun, the teacher would move to another group, leaving the students to work on their own. These students were also glad to depend on themselves out of sight of the video camera.

The teacher did not give the answer to the groups straight away. In fact, this assignment could be completed as homework over the weekend. She was heard saying:

> *You're going to propose a setup, I am not going to comment, let the class decide if your setup is good or need further improvement.*

6.3.5 Uncertain

School X

As noted earlier, interruptions in the lesson delivery was not firmly forbidden. There were signs that the teacher did not want to be portrayed as an authoritarian. Very frequently, she ignored the noise from students' childish behaviours unless it became too disruptive.

School Y and Z

Neither teacher displayed any traits associated with the Uncertain scale. They were confident and eloquent, took on queries, and conducted the lesson smoothly.

6.3.6 Dissatisfied

School X

When some students got progressively noisier, the teacher stopped her teaching and folded her arms, waiting. She only continued after silence was restored.

School Y

This teacher had very good class control. When the students grew excited as their findings unfolded, they became louder. The teacher merely signalled "*Shhh..*" and the students were silent again. There was no teacher dissatisfaction trait observed from her throughout the lesson.

School Z

The teacher was not dissatisfied throughout the lesson. She maintained her smile as she went on her rounds to check on the groups during their discussion.

6.3.7 Admonishing

School X

The teacher did not show irritation at these students' un-cooperative behaviour. She told them calmly, "*I didn't ask you to shout*". Though she warned the class, "*One more time you shout the answer, I'm going to ask you to stand by the side*", this threat was never carried out.

School Y

The teacher corrected students in a manner that was more friendly than admonishing. The students who were making mistakes received light pats on their heads, and the teacher pointed out their mistakes one-to-one neither in threatening nor embarrassing ways.

School Z

This teacher did not display any admonishing behaviours during her class. She interacted with her students in a friendly manner throughout.

6.3.8 Strict

School X

During the initial independent class practice on the family tree, students had to formulate their on own questions with regard to the family tree hierarchy. The teacher forbade them to use their friends' names or make fun of them.

When the class was breaking into small groups for group work, some boys negotiated to stay with their own friends, but the teacher firmly rejected this and put them in their usual group. Then, the students attempted their worksheet assignment in groups of five.

Five groups were formed altogether. The teacher constantly moved from group to group to ensure they were filling in the worksheet appropriately. After completion, she awarded the group some group points, according to her points system.

School Y

The teacher monitored students' work closely. After class instruction was given, the teacher walked around the computer lab, making sure everyone was on task and helping some to catch up. "*Don't jump the sequence*," came the stern and effective warning. Everyone complied. No one was seen to be on the wrong track.

Soon about three students were ahead of their classmates and started talking about their answers. The teacher reminded them, "*Shhh…don't discuss loudly yet, not everyone has found out the answer*". There was instant, lasting silence, reflecting her good classroom discipline.

School Z

To provide for more structure for efficient group discussion, the teacher gave defined roles for the students and put them in pairs within the group to concentrate on a particular area.

The class had a forum where students could post their answers and give comments. She told them, "*Then the others can comment. But I remind you, constructive comments*." It seemed that the teacher was reminding everybody about the rules of posting on the class's forum.

6.4 ATTITUDE TOWARDS SCIENCE

This section presents instances of perceived students' science attitudes during the lesson observations. Students' attitudes are believed to be related to students' achievement, motivation and interest. These qualitative data were collected to complement the quantitative data presented in Chapter 4 and support any associations between QTI scales and Attitude scales.

6.4.1 Attitude to Scientific Inquiry

The Attitude of Scientific Inquiry Scale measures attitude towards scientific experimentation and inquiry as methods of obtaining information.

School X

The class discussion and small group discussion made the students ponder upon their ideas as they were tasked to set questions on their family tree. Students actively evaluated each other's questions and answers to seek improvement.

School Y

Positive attitudes towards scientific inquiry were particularly evident in school Y where students had to find out about Anna Anderson's real identity. They were highly curious and persevered to find out the answer. These students were keen to predict Anderson's identity and made multiple inferences throughout the lesson. They were very motivated to interpret, analyse and evaluate the data provided.

School Z

Students from school Z communicated their ideas effectively during small group discussion. It was conducive and most members of each group earnestly put forth their ideas for the experimental design. They were careful in defining, controlling and manipulating variables in this design task (experimentation).

6.4.2 Adoption of Science Attitude

The Adoption of Scientific Attitudes Scale measures open-mindedness, willingness to reverse opinions related to scientific investigation and inquiry. In addition to open-mindedness and receptiveness, the researcher was also looking out for qualities such as student attentiveness, prompt work submission, ability to think and give in-depth answers and consistent work performance etc.

School X

The students were seen to respond to questions rather quickly, though the teacher gave ample thinking and waiting time. They participated actively during class discussion and some students were seen to be impatient, commenting loudly without raising their hands. The students were seen to be comfortable raising questions whenever in doubt and anxious to clarify immediately.

School Y

Students from School Y were happy to volunteer answers readily and raised questions whenever in doubt. They were eager to complete their task to arrive at a conclusion during the class session. All the students were observed to pay consistent attention to their assignment and no one was seen to be distracted.

School Z

One group of students was asking the teacher, *"Does the size of seed affect the rate of germination?"* They were initially quite certain that size of seed affects germination, until they realised that size was associated with the type of seed planted. The teacher then prompted them about keeping experimental variables constant when designing a fair test. The students kept an open mind when new ideas were presented and were receptive to new perspectives and concepts.

In general, students from school X were seen to be more playful and distracted during lesson, where they frequently talked to their friends, while students from schools Y and Z tended to be more attentive. They also pondered more thoughtfully before giving their answers.

6.4.3 Enjoyment of Science Lessons

The Enjoyment of Science Lessons Scale measures the amount of enjoyment a student experiences in a science class. The researcher looked for evidence of a happy and relaxed learning environment for the students. Particular attention was paid to whether the students were smiling, eager to respond to questions, and keen to participate in activities.

School X

Students from School seemed relaxed and jovial. A few boys from the class observed were talking during lesson and sometimes even joked with one another and even with the teacher. This class had an informal classroom setting with a lenient classroom culture.

School Y

When instruction was given out, students were listening attentively, which clearly showed that they were interested in what was happening. When independent work was assigned, they were highly engaged.

School Z

Students from this school were responsive to the teacher's questions and were keen to participate in the class discussion. Students continued to brainstorm after forming their small groups cooperatively.

The students from the schools observed were relaxed and comfortable. They were keen to participate in activities. Students from schools X and Z enjoyed the workgroup assigned and students were highly engaged in independent work in school Y.

6.5 DISCUSSION

From the lesson observations, a very distinct characteristic of science teachers in the GEP is that their lessons are carefully conceived. The lessons flow smoothly and are usually student-centred. The teachers take control of the classes and students can always count on them for direction. This probably explains why the Leadership scale has the highest mean score from the QTI analysis.

Another noteworthy observation is that the majority of students appreciate a conducive learning environment where the lesson can be engaging. From the observer's perspective, if the students do not show maturity and cooperation in class, it is difficult for teachers to conduct new activities. Being bored by theory lessons at most times, they misbehaved, continuing the unfortunate cycle, which was supported by the interview item in Chapter 5. From the observations, there is also support for the claims given in the interviews that they prefer a non-chaotic classroom, i.e. well organised.

The teacher's behaviour and the class dynamics work in a cyclic manner where they constantly influence each other. Both parties need to work hand in hand to maximize learning.

It is a pity that none of the classes volunteered a science experiment lesson to be observed, where other valuable information could be drawn.

Another special feature in the GEP classroom worth mentioning is the high frequency of group work. The teachers have the luxury of time (and classroom space) to carry out small group discussion very frequently, owing to the small class size. They have opportunities to manage every group and monitor learning progress. Students enjoy such strategies as it is student-centred and meaningful to learn from each other.

IT was an integrated part of daily lessons, something which the students expect and are comfortable with. Most of them love mingling around and hence benefit from the interactive experience (Ricca, 1984).

During lesson observations, the researcher was also aware that it is also highly possible that the presence of an observer may change the teacher-student interactions occurring, especially when students and teachers may become more self-conscious. In this aspect, the researcher has taken note not to interfere with the classroom dynamics and report the findings from a neutral stance.

6.6 CHAPTER SUMMARY

This chapter is written to provide some insights into a typical GEP science classroom. Gifted students display a range of personalities and behaviours, thus more attention and customised teaching is dedicated to each student to maximise his/her learning potential. Gifted students are more confident and vocal and they appear to enjoy science more if the lesson is more interactive.

Observations from three gifted classes revealed that gifted students enjoyed being challenged cognitively and appreciate flexibility in learning strategies. In GEP,

students are exposed to more student-centred science lessons as opposed to didactic teaching, for example, group discussion or discovery learning. Teachers act as facilitators to guide them along.

In the next chapter, conclusions are drawn from this study and limitations discussed. In addition, directions for future research are also explored and outlined.

CHAPTER SEVEN

CONCLUSIONS, LIMITATIONS AND FUTURE DIRECTIONS

7.1 INTRODUCTION

The main aim of this research study was to investigate teacher-student interactions in primary science gifted classes in Singapore. These gifted students formed the top 1% of the cohort, approximately 500 students per level each year. A representative number of 279 students participated in this research and this final chapter concludes the thesis in the following way: an overview of the structure of the thesis is presented in Section 7.2; the major findings of the research are presented in Section 7.3; the significance and implications of this research are discussed in Section 7.4; limitations of the research study are noted in Section 7.5; possible future directions from the outcomes of this research are considered in Section 7.6; and a summary of the chapter is given in Section 7.7.

7.2 OVERVIEW OF THE RESEARCH DESIGN

The research reported in this study is about teacher-student interaction in Singapore gifted science classes. Quantitative data were collected using the instruments of the QTI and Attitude to Scientific Inquiry, Adoption of Scientific Attitude and Enjoyment of Science Lesson scales from the TOSRA. The sample size of 279 participants represented a significant percentage (56%) of the Primary 5 level gifted students in Singapore. The use of interviews and classroom observations further validated the findings from the quantitative questionnaire.

Qualitative data were collected from a smaller group of interviews with 22 student volunteers from participating schools. Each group interview lasted about 40 minutes to gain more insights into the science classroom environment. Classroom observations were also conducted in three classes to further support the qualitative data obtained from the interviews. Both the interviews and observations were

recorded in the form of field notes, audio and video files. The data were later transcribed to complement the quantitative data obtained.

The SPSS software package provided statistics for the QTI and the adapted TOSRA scales. The Cronbach alpha coefficients on reliability, discriminant validity and ability to differentiate between classrooms were calculated using the individual student as the unit of analysis. Differences between male and female students' perceptions toward their science teachers, differences between teacher and student perceptions and differences between teacher self and ideal perceptions were investigated. The relationships between the scales of the QTI and the Attitude scales and cognitive test scores were first examined using the Pearson's sample correlation procedure. Regression analysis was then used to examine the contribution of the QTI scales to each attitude and cognitive outcome variable. By utilising information from quantitative and qualitative methods to triangulate, the validity of research results could be enhanced.

7.3 MAJOR FINDINGS OF THE STUDY

The research results from this study are presented in the section below, according to the research questions listed in Section 1.3.

7.3.1 Research Question 1

Is the QTI a valid and reliable questionnaire in primary science gifted classrooms in Singapore?

Results from the study in Section 4.2 indicated that the 48-item version of the QTI is a valid and reliable instrument for the assessment of students' perceptions in Primary science gifted classes in Singapore. The alpha reliability of the scales ranged from 0.69 to 0.88 when the individual student was used as a unit of analysis. All QTI scales significantly differentiated between classes and the eta^2 statistics ranged from 0.04 to 0.07. As well, high correlations were found between neighbouring scales of the QTI and negative correlations between opposite scales confirming the circumplex nature of the QTI model.

Overall, the QTI is a valid and reliable questionnaire in the primary science gifted classroom, confirming the findings of previous studies (e.g., Fisher et al., 1993b; Waldrip & Fisher 2003).

7.3.2 Research Question 2

Are the three Attitude scales adapted from the TOSRA valid and reliable variables in primary science gifted classrooms?

Results from the study presented in Section 4.3 indicated that the Attitude to Scientific Inquiry, Adoption of Scientific Attitude and Enjoyment of Science Lessons scales are valid and reliable scales for the assessment of students' science attitudes in primary science gifted classes in Singapore. The alpha reliability of the scales ranged from 0.76 to 0.96, showing high internal consistency. The discriminant validity of 0.26 to 0.36 shows that these scales measure distinct but somewhat overlapping attitudes range.

Overall, these three Attitude scales adapted from the TOSRA formed a valid and reliable attitudinal instrument for use in primary science gifted classroom.

7.3.3 Research Question 3

What are gifted students' perceptions of their science teachers' behaviours in the classroom?

This study found that students perceive their teachers to display high levels of leadership, helping/friendly and understanding behaviours and low levels of uncertain behaviours. They suggest that teachers are generally strict and monitor their academic and affective progress closely.

Overall, the highest means were on the Leadership scale qualities and the lowest means were on the Uncertain scale.

7.3.4 Research Question 4

Are there any associations between gifted student perceptions of teacher interpersonal behaviour and student attitudinal and cognitive outcomes?

Associations between gifted student perceptions of teacher interpersonal behaviour and attitude to scientific inquiry.

The simple correlation (*r*) shows that Leadership and Helping/Friendly scales are correlated to attitude to scientific inquiry ($p<0.01$). The beta weights reveal that the Leadership scale was positively and significantly associated with attitude towards scientific inquiry ($p<0.05$). The multiple correlation coefficient *R* gives a value of 0.23. The R^2 figure indicates that 3% of the variance in students' attitude towards scientific inquiry can be attributed to their perception of teacher's interpersonal behaviour.

Overall, when the effect of all the QTI scales is controlled the greatest impact on students' attitude to scientific inquiry was teacher leadership behaviour.

Associations between gifted student perceptions of teacher interpersonal behaviour and adoption of scientific attitude.

The simple correlation (*r*) shows that all eight scales of the QTI are correlated to adoption of scientific attitude ($p<0.05$). The beta weights reveal that students' positive attitude towards science was particularly evident when the students perceived higher levels of leadership behaviour in their teacher. Only the Leadership scale retained its significance and was positively and significantly associated with Adoption of Scientific Attitude in science classes. The multiple correlation coefficient *R* gives a value of 0.52. The R^2 figure indicates that a considerable 27% of the variance in student adoption of scientific attitude can be attributed to their perception of teacher's interpersonal behaviour.

Again, when associations between the QTI scales is controlled for, the greatest impact on students' adoption of scientific attitudes was the student perceptions of teacher leadership behaviour and.

Associations between gifted student perceptions of teacher interpersonal behaviour and enjoyment of science lesson.

The simple correlation (*r*) shows that all eight scales of the QTI are correlated to enjoyment of science lesson ($p<0.01$). The beta weights show that students' enjoyment of science lesson was particularly evident when the students perceived higher levels of leadership and helping/friendly behaviour in their teacher. Conversely, students who perceive their teachers as showing higher level of admonishing behaviour have lower level of enjoyment of science lessons. The β values showed that Leadership (0.36), Admonishing (-0.23), Helping/ Friendly (0.16) behaviours have the greatest significant effects ($p<0.05$, $p<0.01$, $p<0.001$ respectively)**.** The multiple correlation coefficient *R* gives a value of 0.69. The R^2 figure indicates that 48% of the variance in the students' enjoyment of science lesson can be attributed to their perception of their teacher's interpersonal behaviour.

The examination of the beta weights indicated that a significant positive association between gifted students' perceptions of teacher leadership behaviour and enjoyment of science lesson and significant negative association between admonishing behaviour and enjoyment of science lesson is retained.

Associations between gifted student perceptions of teacher interpersonal behaviour and cognitive outcomes.

The simple correlation (*r*) and standardised regression weight (β) were computed between cognitive achievement and each individual QTI score when all other QTI dimensions are controlled.

There were six significant simple correlations ($p<0.05$, $p<0.01$), out of eight scales of the QTI. These associations were significantly positive for the scales of Leadership, Helping/Friendly, Understanding, and Student Responsibility/Freedom for student cognitive achievement. The scales of Dissatisfied and Admonishing displayed significantly negative associations.

An examination of the beta weights revealed that only two of the eight scales retained their significance when associations between the QTI scales were controlled. The Strict scale was positively associated and the Dissatisfied scale negatively

associated with the cognitive achievement of the students. The multiple correlation coefficient *R* gives a value of 0.28. The R^2 figure suggests that 8% of the variance in the students' cognitive test result can be attributed to their perception of their teacher's interpersonal behaviour.

An examination of the beta weights indicated that significant associations were retained with the Strict and Dissatisfied scales. There is significant positive association between gifted student perceptions of teacher strict behaviour and cognitive achievement and significant negative association between dissatisfied behaviour and cognitive achievement.

7.3.5 Research Question 5

Are there any differences in gifted student and teacher perceptions?

This study reports that students perceived their teachers as displaying less leadership, helping/friendly and understanding behaviours than the teachers perceived themselves to be. Similarly, students also perceived their teachers as exhibiting less uncertain, dissatisfied, admonishing and strict behaviours than the teachers did themselves. Two out of the eight scales have the smallest mean difference in teacher self-perception and student perception, namely, the Leadership and Student Responsibility/Freedom scales. In this comparison, students perceive the teachers somewhat between the teachers' self-perception and the teachers' perception of their ideal teacher.

Overall, there are some differences in gifted student and teacher perceptions.

7.3.6 Research Question 6

What are the types of science teachers in the GEP in Singapore, based on the Australian QTI-based typologies?

This study reports that Singapore GEP science teachers are perceived to portray a tolerant/authoritative teacher behavioural pattern which is characterised by a pleasant

and well-structured environment in which the teacher has a good relationship with students. While the tolerant/authoritative pattern of behaviour besides being assertive is also aware of students' needs, the tolerant/authoritative teacher develops close relationships with students. They enjoy the class and are highly involved in most lessons. Tolerant/authoritative teachers maintain a structure which supports student responsibility and freedom. They use variety of methods, to which students respond well.

7.3.7 Research Question 7

Are there any gender-related differences in perceptions of gifted students in their science classes?

Gender-related differences in perceptions of gifted students in science classes were found to be statistically insignificant, suggesting that, for this sample, male and female students viewed their science teachers very similarly.

7.4 SIGNIFICANCE AND IMPLICATIONS OF THE STUDY

This study is significant for several reasons. First, this is the first major study in the world of the teacher-student interaction in science classroom learning environments conducted among primary gifted students. It provides valuable information about GEP in Singapore as indicated in this section. Secondly, the QTI has never been administered in Singapore for primary science students in the gifted stream and thus is the first study on gifted students in the primary science context. Finally, the research method used in the study is focused on gaining detailed qualitative data about a small number of students but against a background of more general quantitative information from surveys of a larger group. The sample size of 279 students was about 56% of the Primary 5 GEP student population and hence formed a representative group. Quantitative findings derived from this sample are therefore substantially significant.

Primary 5 gifted students' perception of the teachers' interpersonal behaviour in this study suggests that students should continue to receive more leadership and help

during science lessons. An examination of the beta weights indicates that the Leadership scale is a significant predictor of the gifted students' attitudes to science. The extent to which the teacher provides leadership of the class and holds student attention is vital in building positive learning attitude in students. At the same time, the teacher's behaviour should be maintained at being helping/friendly and understanding to establish rapport and cater for students' interest. These findings about teacher-student interactions are particularly useful to the administrators, teachers and other stake-holders. From the teachers' perspective, the findings could help science teachers to reflect on the various aspects of their science classes, their interactions with students and their teaching approaches regarding the classroom environment. For the students, the findings also provide a better understanding of the students' perceptions of the teacher-student interactions that could help the gifted, as well as high-ability learners to communicate and learn better in the future.

The results of associations between teacher-student interactions and attitudinal and cognitive outcomes support the assertion of Fraser (1994) that the nature of classroom environment has a potent influence on how well students achieve desired outcomes. Therefore, practical strategies for improving learning environment and the teacher's behaviour should be considered as a means for improving students' attitudes towards science classes (Fraser, 1998b).

A further implication would be that we might improve the primary science gifted curriculum package by customizing instruction to meet the learning needs of the learners, incorporating more lively and practical approaches and infusing scientific inquiry, creative and critical thinking skills into both theory and practical lessons.

Students' interviews suggest that teachers might adopt a more creative teaching and learning approach in the gifted science class as a necessary move. The teachers concerned ideally would establish an intellectually-stimulating classroom. Teachers might also use a variety of resources and materials to create divergent learning tasks or situations.

The findings with the QTI could help teachers be more aware of the dynamic teacher-student interactions taking place in the classroom. With an understanding of

the dynamics of the communication process, we can learn to manage the learning environment more effectively.

7.5 LIMITATIONS OF THE STUDY

One limitation of the study was internal validity. The researcher was also the science teacher for two of the 15 classes (13%). Data from the researcher's classes could be subjected to biasing influences such as 'demand characteristics' (participants respond in accordance with their perceptions of the expectations of the research and their teachers) (Hersen & Barlow, 1976). We know that people typically provide socially acceptable responses that might not be valid (Anderson, 1998).

Due to time constraint in a tight curriculum, there was limited opportunity for administering the questionnaires and interviews. The researcher was unable to pilot test the QTI and 30-item attitude scales to assess the students' understanding of the scale items. After the questionnaire, there was feedback from teachers that some students found some items too general, but had to make the best meaning out of the statements, in their current classroom context. This may have had implications for meanings of certain words in the questionnaire, although the statistical analysis indicated that the instruments used were valid and reliable.

7.6 DIRECTIONS FOR FUTURE RESEARCH

This present research might pave the way for new longitudinal studies of Singapore gifted students on classroom environments and student outcomes, as past studies on gifted secondary students also showed that the interpersonal behaviour of teachers had an impact on the students' attitudes (Quek, Wong, & Fraser, 2005a)

This research study could be replicated in other subject areas such as mathematics or social studies in the gifted education programme. These are equally important subject areas where students are stretched to maximize their learning potential. Any findings of associations between teacher-student interaction and student outcomes would be beneficial to all stakeholders of gifted education.

There are about 500 GEP students at each primary level from Primary 3 to Primary 6. Future studies on gifted children might consider gathering data from various levels for more quantitative data to achieve higher reliability and validity, when the instruments are used in advanced statistical analysis (Coakes & Steed, 1999).

The present research could also be replicated with a larger sample of mainstream students from the high-ability, middle-ability and low-ability group. These different groups of students may have differing perceptions based on their experiences and learning pace to offer new insights in the rich field of learning environments research.

7.7 CHAPTER SUMMARY

This chapter has concluded the study of gifted children in their primary level science classes in Singapore. Their perceptions of their science teachers were investigated using the QTI instrument, as well as data from students' interview and classroom observations. Associations between students' attitudes and their perceptions of teacher-student interaction were established. Associations between their cognitive achievement and their perceptions of teacher-student interaction were also determined.

As a result, this study provided the first validation data for the QTI with gifted students in the science learning environment. These validation data were construct validated with both interview and classroom observation data.

This study could be useful for educators who are interested in improving attitudinal and achievement outcomes in gifted education programmes.

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APPENDIX A

Information Sheet

You are invited to take part in a research study. This information sheet is to provide you with a better understanding of the purpose of this research. The investigator for the research study will be available to answer your questions and provide further explanations. Your decision to take part in the study is voluntary.

My name is Lee Yoke Cheng and I am the investigator for this research study. I am pursuing a PhD degree at Curtin University, Perth. My supervisor is Prof. Darrell Fisher (email d.fisher@curtin.edu.au). The aim of my research study is to find out about the perceptions of students of their teachers in Science classes and the effects on their achievements. I need to gather your opinion about the learning environment of your class by filling up a questionnaire. This should take about 15 minutes. In other separate sessions, I need to interview some teachers (individually) and students (in pairs). The duration of each interview is no longer than 30 minutes.

One classroom lesson (60 minute) per volunteered teacher will be video-taped to observe the teacher-student interaction in class.

I am not collecting any personal data from you and your responses will be made anonymously. Your participation in this survey is entirely voluntary and you are at liberty to withdraw at any time with prejudice or negative consequences. I will assume that you give your consent to completing this survey if you hand in the completed questionnaire forms.

When my analysis of survey results is completed I will give feedback to the class of these results and we will use them in generally considering learning environments in Science classes. This will be of benefit to your preparation in teaching Science.

If you have questions about the procedures of this research study, please contact me at 96828420 during workdays.

If you want to make a complaint on ethical grounds please contact:
The Secretary, HREC
Office of Research and Development
PO Box U1987
Perth WA 6845
Australia
http://research.curtin.edu.au/ethics/hrec.html#contact

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

APPENDIX B

Dear Principal,

I am currently a P5 GEP Science teacher in Henry Park primary. I am pursuing my PhD research with Curtin University in Science Education and would like to seek your permission to collect data from your school's GEP pupils and teacher in Term 2 and 3.

The title of my research is *Students' perceptions of Science teacher interpersonal behaviour in primary Science (gifted) classroom and the effects on student achievement.* (tentative)

My objective is to find out how the teacher-student interaction in classroom affects the pupil learning attitude and test achievements.

My area of data collection includes:

1) 10-minute questionnaire for all P5 GEP pupils and teacher.
2) Classroom observation – 60 min video taping. This qualitative data is voluntary and subjected to your teacher's consent. GEB has notified us (science teachers) that it will be observing our 2-period lesson (1 class only) some time later in the year. I hope to use this opportunity to video the same lesson. The GE science officer who is observing the lesson is able to help with the recording and your teacher keeps the tape after data is decoded.
3) Pupils interview – about 10- min interview, in pairs. I would like to conduct pupil interview with 2 – 4 pupils per GEP class to gather more insights on their teacher-student interaction. Parental consent from these selected pupils would be sought.

The processed findings would be shared with your teacher involved. As I have been working with your P5 GEP teacher closely this year, I would like to assure you that there will not be disruptions to her teaching schedule. All schools, teachers and pupils are to remain anonymous in my final thesis. Details of data collection would be discussed your P5 GEP science teacher.

Letters of approval from Curtin and MOE and Questionnaires are also attached for your reference.

Thank you for your attention.

Best regards,
Yoke Cheng

APPENDIX C

Consent Form for Teachers

I have read and understood the information given in the information sheet. I agree to my participation in the research project as outlined above and to Lee Yoke Cheng using the information gained from the research in her PhD project. I understand that I may withdraw from the research at any time. I also understand that the research will involve the following data gathering activities, and consent to the researcher using these materials for her research:

Video tape recordings of classroom lesson
Teacher interviews
Teacher questionnaires

Name: _____

Signature: _____ Date: _____

APPENDIX D

7 May 2007

Dear Parent,

I am currently a P5 GEP science teacher in Henry Park Primary School, pursuing a PhD degree with Curtin University of Technology, Perth, Western Australia. I am conducting a research study on selected GEP science classes.

Your child is invited to take part in a 15-min interview (in pairs) after a class observation to find out about the perceptions of students of their teachers in Science classes and the effects on their achievements. All participants are to remain anonymous in the published data.

This research is approved by Curtin University Human Research Ethics Committee, MOE Singapore, as well as Principals of the participating schools.

Best regards,

Lee Yoke Cheng (Ms)
lee_yoke_cheng@moe.edu.sg

I allow / do not allow my child _____ of P5 ( )
to take part in the above-mentioned interview.

Parent's Signature _____

Date _____

Questionnaire on Teacher Interaction

Your Ideal Teacher Questionnaire

The following questionnaire asks for your view of an ideal teacher's behaviour. Think about your ideal teacher and keep this ideal teacher in mind as you respond to these sentences.

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

	Never				Always
The teacher would express herself/himself clearly.	1	2	3	4	5

If you think that ideal teachers always express themselves clearly, circle the 5. If you think ideal teachers never express themselves clearly, circle the 1. You also can choose the numbers 2, 3 and 4 which are in-between. If you want to change your answer, cross it out and circle a new number. Thank you for your cooperation.

In order for us to provide you with a report of the results, please write your name and other details at the top of the reverse side of this page.

APPENDIX E

Name_____ School_____

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

APPROVED BY

Teo Kie Eng (Miss)
Head, Data Administration 3
Data Administration Centre
Ministry of Education

Questionnaire on Teacher Interaction

Teacher Self Questionnaire

This questionnaire has 48 sentences about your behaviour in a particular class.

For each sentence, circle the number corresponding to your response. For example:

						Never
Always						
I express myself clearly.		1	2	3	4	5

If you think that you always express yourself clearly, circle the 5. If you think you never express yourself clearly, circle the 1. You also can choose the numbers 2, 3 and 4 which are in-between. If you want to change your answer, cross it out and circle a new number.

Thank you for your cooperation.

In order for us to provide you with a report of the results, please write your name and other details at the top of the reverse side of this page.

APPENDIX F

Name _____School_____	Never				Always
1. I talk enthusiastically about my subject.	1	2	3	4	5
2. I trust the students.	1	2	3	4	5
3. I seem uncertain.	1	2	3	4	5
4. I get angry unexpectedly.	1	2	3	4	5
5. I explain things clearly.	1	2	3	4	5
6. If students don't agree with me, they can talk about it.	1	2	3	4	5
7. I am hesitant.	1	2	3	4	5
8. I get angry quickly.	1	2	3	4	5
9. I hold the students' attention.	1	2	3	4	5
10. I am willing to explain things again.	1	2	3	4	5
11. I act as if I do not know what to do.	1	2	3	4	5
12. I am too quick to correct students when they break a rule.	1	2	3	4	5
13. I know everything that goes on in the classroom.	1	2	3	4	5
14. If students have something to say, I will listen.	1	2	3	4	5
15. I let the students take charge.	1	2	3	4	5
16. I am impatient.	1	2	3	4	5
17. I am a good leader.	1	2	3	4	5
18. I realise when students don't understand.	1	2	3	4	5
19. I am not sure what to do when students fool around.	1	2	3	4	5
20. It is easy for students to have an argument with me.	1	2	3	4	5
21. I act confidently.	1	2	3	4	5
22. I am patient.	1	2	3	4	5
23. It's easy to make me appear unsure.	1	2	3	4	5
24. I make mocking remarks.	1	2	3	4	5
25. I help students with their work.	1	2	3	4	5
26. Students can decide some things in my class.	1	2	3	4	5
27. I think that students cheat.	1	2	3	4	5
28. I am strict.	1	2	3	4	5
29. I am friendly.	1	2	3	4	5
30. Students can influence me.	1	2	3	4	5
31. I think that students don't know anything.	1	2	3	4	5
32. Students have to be silent in my class.	1	2	3	4	5
33. I am someone students can depend on.	1	2	3	4	5
34. I let students decide when they will do the work in class.	1	2	3	4	5
35. I put students down.	1	2	3	4	5
36. My tests are hard.	1	2	3	4	5
37. I have a sense of humour.	1	2	3	4	5
38. I let students get away with a lot in class.	1	2	3	4	5
39. I think that students can't do things well.	1	2	3	4	5
40. My standards are very high.	1	2	3	4	5
41. I can take a joke.	1	2	3	4	5
42. I give students a lot of free time in class.	1	2	3	4	5
43. I seem dissatisfied.	1	2	3	4	5
44. I am severe when marking papers.	1	2	3	4	5
45. My class is pleasant.	1	2	3	4	5
46. I am lenient.	1	2	3	4	5
47. I am suspicious.	1	2	3	4	5
48. Students are afraid of me.	1	2	3	4	5

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Questionnaire on Teacher Interaction

Student Questionnaire

This questionnaire asks you to describe the behaviour of your teacher.

This is NOT a test.
Your opinion is what is wanted.

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

	Never				Always
This teacher expresses himself/herself clearly.	1	2	3	4	5

If you think that your teacher always expresses himself/herself clearly, circle the 4. If you think your teacher never expresses himself/herself clearly, circle the 1. You also can choose the numbers 1, 2 and 3 which are in-between.

If you want to change your answer, cross it out and circle a new number.

Please answer all questions.

Thank you for your cooperation.

APPENDIX G

Name (if requested)_____

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

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43. This teacher seems dissatisfied.	1 2 3 4 5
44. This teacher is severe when marking papers.	1 2 3 4 5
45. This teacher's class is pleasant.	1 2 3 4 5
46. This teacher is lenient.	1 2 3 4 5
47. This teacher is suspicious.	1 2 3 4 5
48. We are afraid of this teacher.	1 2 3 4 5

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APPENDIX H

School:_____ Date: _____

Name: _____ ( ) Class: 5 ( )

☐ Male ☐ Female

Science Related Attitudes

Items 1 -30 below consist of a number of statements about the science class which you are in right now. Your opinion is what is wanted. There is no right or wrong answers.

For each statement, draw a circle around

1 if you **strongly disagree** with the statement
2 if you **disagree** with the statement
3 if you are **not sure**
4 if you **agree** with the statement
5 if you **strongly agree** with the statement

No.		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1	I would prefer to find out why something happens by doing an experiment than by being told.	1	2	3	4	5
2	I enjoy reading about things which disagree with my previous ideas.	1	2	3	4	5
3	Science lessons are fun.	1	2	3	4	5
4	Doing experiments is not as good as finding out information from teachers.	1	2	3	4	5
5	I dislike repeating experiments to check that I get the same results.	1	2	3	4	5
6	I dislike science lessons.	1	2	3	4	5
7	I would prefer to do experiments than to read about them.	1	2	3	4	5
8	I am curious about the world in which we live.	1	2	3	4	5
9	Schools should have more science lessons each week.	1	2	3	4	5
10	I would rather agree with other people than do an experiment to find out myself.	1	2	3	4	5
11	Finding out about new things is unimportant.	1	2	3	4	5
12	Science lessons bore me.	1	2	3	4	5
13	I would prefer to do my own experiment than to find out information from a teacher.	1	2	3	4	5
14	I like to listen to people whose opinions are different from mine.	1	2	3	4	5
15	Science is one of the most interesting school subjects.	1	2	3	4	5

APPENDIX H

No.		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
16	I would rather find out about things by asking an expert than by doing an experiment.	1	2	3	4	5
17	I find it boring to hear about new ideas.	1	2	3	4	5
18	Science lessons are a waste of time.	1	2	3	4	5
19	I would rather solve a problem by doing an experiment than be told the answer.	1	2	3	4	5
20	In science experiments, I like to use new methods which I have not used before.	1	2	3	4	5
21	I really enjoy attending science lessons.	1	2	3	4	5
22	It is better to ask the teacher the answer than to find out by doing experiments.	1	2	3	4	5
23	I am unwilling to change my ideas when evidence shows that ideas are poor.	1	2	3	4	5
24	The material covered in science lessons is uninteresting.	1	2	3	4	5
25	I would prefer to do an experiment on a topic than to read about it in science magazines.	1	2	3	4	5
26	In science experiments, I report unexpected results as well as expected ones.	1	2	3	4	5
27	I look forward to science lessons.	1	2	3	4	5
28	It is better to be told scientific facts than to find them from experiments.	1	2	3	4	5
29	I dislike listening to other people's opinions.	1	2	3	4	5
30	I would enjoy school more if there were no science lessons.	1	2	3	4	5