Science and Mathematics Education Centre

An Investigation of Students' Perceptions of Teacher Support and Equity in the Classroom and their Impact on Students' Attitudes Toward Science

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Declaration

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

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

Signature ……………………………

Date …………………………………

ABSTRACT

This study investigated the relationship between students' perceptions of learning environments and their attitude to science in Australian secondary schools. It focussed on teacher support and equity in the lower secondary school years of 8, 9, and 10. Teacher Support and Equity are two of the five scales of the *What Is Happening In this Class* (WIHIC) questionnaire. The scale to measure Attitude to Science was drawn from the *Test of Science Related Attitudes* (TOSRA). Using the statistical package SPSS, gender differences and year level differences were examined for each of the scales. Results showed that the females rated the scales of Teacher Support and Equity more highly than did the males but the males had a more positive attitude to science than did the females. The Year 9 students were considerably less positive than those from years 8 and 10 on all three scales. Of the three scales, Equity received the highest rating across all the groups, while Attitude scored the lowest. Regression analysis showed statistically significant and positive associations between Attitude to Science and the Teacher Support and Equity scales. These results were consistent when tested separately for the male and female students, and for each of the year levels. To gain insights into science teaching and learning from a teacher's perspective, one primary teacher, two high school teachers, and one pre-service teacher were interviewed. Their comments were found to support the quantitative results in that they agreed that teacher actions or inactions within the learning environment would affect the students' attitude to science. They expressed the view that students needed to feel able to ask questions without criticism and receive the help they needed to progress, which corresponded to the Teacher Support scale. They also felt that it was not appropriate for teachers to favour any group of students over any other, thus supporting the concept of the Equity scale. The findings will assist teachers to develop strategies to address the problem of students' declining attitude to science, a problem that is viewed as a potential threat to the economic future of Australia.

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CHAPTER ONE

INTRODUCTION AND OVERVIEW

1.1 Introduction

Education is 'the development of knowledge, skills, ability, or character by teaching, training, study, or experience' ('Education', 1982). In our society, school and university teachers are the primary deliverers of education. It is estimated that a student will spend some 7,000 hours learning while at primary school, complete 15,000 hours of learning up to the end of high school, and 20,000 hours in pursuit of knowledge by the time they finish their university course (Fraser, 2001). However, education is not restricted to the delivery of factual material. It also consists of involvement in the environment where that learning takes place – the experience of learning.

The nurturing environment of the primary school setting is where the basic skills of general/generic learning begin to develop. At this early age some students may demonstrate a particular talent for perhaps sport or music, but the education focus is more on developing a grounding in all subjects – a grounding that is then built on at the junior high school level. Again, students may then begin to show a particular talent or develop special interests as their knowledge grows. In senior high school those special talents and interests often become the main subjects of choice as students begin to consider and map out their future. The university setting, of course, takes the student very much along the path of specialising only in the subjects of interest or areas of talent. Science is just one of the subject areas that a student may choose (or not choose) to study when they move into post-compulsory education; once they begin to make the choices for their future. It is the *not choosing* that is of concern.

In an address to the National Press Club of Australia in August 2006, the Honourable Julie Bishop MP, Federal Minister for Education, Science and Training, opened by saying that Australia "maintains a high standing in the international science community" as demonstrated by the fact that it has the highest number of Nobel Prize Winners per capita in the world. She went on to say that:

> We are a nation that depends on innovation to underpin our prosperity. The world today is driven by the exponential growth in human knowledge. Australia must continue to exploit new knowledge, to adopt innovative ideas and harness new technologies to maintain our quality of life, both social and economic. (p. 2)

Despite the importance of science to the Australian community, a government commissioned audit showed that the numbers of people taking up science studies was declining and would not be sufficient to meet projected demand for such skills for the future. Whilst the numbers of Year 12 students taking science courses had been static in recent years, numbers were still well down on earlier times and the best students were no longer attracted to the discipline. Engagement with science begins in schools and should start at the earliest possible time in the education process. Pre-school and primary school science needs to be stimulating and fun. Junior high school science needs to excite students and inspire them to continue their studies. Senior high school science students need to understand the value of scientific knowledge and the role it will play in their futures (Bishop, 2006).

Similar views to those of the Minister had been expressed in a policy framework document by the Australian Council of the Deans of Science (2004). It stated that one of the roles of Deans of Science of Australian Universities was to be 'advocates for the development of the current and next generation of scientists' (p. 1). The document went on to list four reasons for this: (1) to sustain a leading source of the nation's research innovation and creativity; (2) to provide the impetus for the generation and exploitation of intellectual property for economic advancement in Australia; (3) to redress the current declining interest in the enabling sciences, particularly mathematics, physics and chemistry, and the shortage of science teachers; and (4) to provide the enabling basis for engineering, medicine, agriculture, information technology and applied science generally. One of the ways the document proposed to achieve these was to "promote science at every appropriate opportunity"

(p. 1). Making science education an attractive and viable option for students of all ages is perhaps one of the most basic ways of doing that promoting.

In a research report entitled ‘The Status and Quality of Teaching and Learning of Science in Australian Schools” published by the Department of Education, Training and Youth Affairs (DETYA), Goodrum, Hackling, and Rennie (2001) found that there was considerable variability in science teaching and learning within Australian schools. They expressed the view that when regularly taught in primary schools, science received a high level of student satisfaction because classes were often activity based and student centred. However, science is not always included at the primary level where the curriculum is often concerned with the learning of more generic skills such as the three Rs.

When students move on to high school, where science is a required subject area, the authors reported that the chalk and talk style of teaching and the use of material that was apparently irrelevant to the students did not encourage interest or involvement. The negative attitude to science was reflected in the declining numbers of students who took science subjects in the post-compulsory years of schooling (Goodrum et al., 2001).

These three reports all expressed the view that delivering a quality science education to students at all levels was vital for the future prosperity of Australia and that addressing the declining numbers of students engaging in science was of paramount importance. Bishop (2006) stated that:

> With an unacceptably high rate of opting out of science studies during early years of high school, we need to engage and excite young people about science ... to inspire them to continue their studies. (p. 6)

Education has changed considerably since the early 1800s when just being able to read or write was an achievement. A rapid explosion of information and knowledge has accompanied the transition through the mass education of the 1900s where the end product was a good assessment mark. In the 21st century, the amount of knowledge to be learned is such that learning how to learn and understanding the need to be a lifelong learner is the necessary and favoured outcome. Graduates of the school system now are expected to be able to identify and solve problems, to adapt and apply their learning, and to make a contribution to society (Bransford, Brown, & Cocking, 1999).

Learning science can be more than just learning facts. It can bring about the sort of scientific literacy that Marlino (1997) identified as enabling “people to use scientific principles and processes in making personal decisions and to participate in discussions of scientific issues that affect society” (p. 1). She added that one of the consequences of learning science properly was the acquiring of valuable transferable skills such as problem solving, thinking critically, working cooperatively, using technology effectively, and valuing life-long learning. If students choose not to learn science, however, these outcomes become less achievable.

Past research has shown that there is an association between students’ perceptions of their learning environment, and cognitive and affective learning outcomes in a variety of settings and education levels and using a variety of instruments (Fraser, 1998). In 1972, Shulman and Tamir (cited by Henderson, Fisher, & Fraser, 1998) suggested that affective outcomes are equally as important as cognitive ones in education. For many of the early years of educational research, the focus was on cognitive outcomes as a measure of achievement. The past three decades, though, have brought increased interest in student attitudes as a major part of the important affective domain (Henderson, Fisher, & Fraser, 1998).

It is hard to separate today’s world from science and technology. If the world is to develop further, the scientific approach of finding or determining answers to questions derived from curiosity about everyday experiences, current and future students need to recognise the importance of science and choose to include it in their education process. Making science a required part of primary school learning or changing the method of delivery in the high school years will take time and effort on the part of administrators and curriculum designers. In the interim, practical but immediate solutions need to be identified that, if put into practice, could help to address the declining popularity of science – to improve students’ attitude to science.

Young adolescents experience a myriad of conflicts and problems as they encounter the differing situations that society in general, and education in particular, present to them. Identifying and meeting the specific needs of students during those years has been a concern for school systems for some time (Ferguson & Fraser, 1999). Research has focused on the transition from primary to secondary schools and the problems that the move brings, with some studies drawing particular attention to the deterioration in students' attitudes at this time. Speering and Rennie (1996) conducted research on science learning environments and found that the decline in attitude to science seemed to be connected to the changes in student-teacher relationships experienced in the early high school science classroom. The transition from primary to secondary school usually meant a change from a non-specific environment, where students had the one classroom and the one teacher, to one that is subject focused with many physical rooms and many teachers. They also suggested that it is during the first and second year of secondary school that students form their attitude to science subjects and that those attitudes can have a lasting effect on ongoing science interest.

Findings such as these and an interest in the impact of student – teacher relationships within the learning environment prompted the present study. The purpose is to investigate the relationship between students' perceptions of aspects of the learning environment and their attitude to science classes. The aspects of the learning environment focussed on here are those of teacher support, and of equity in the junior high school science classrooms. Junior high school is defined as years 8, 9 and 10.

The provision of support and equitable treatment in the classroom are behaviours that can be modified through teacher awareness rather than training and have the opportunity to give immediate results. Changes made that affect students' attitude to science during the vital and impressionable junior high school years are changes that will affect the students' ongoing pursuit of scientific knowledge.

1.2 Background to the study

Historically, educational research used the skills of trained personnel who recorded and coded the teacher and/or student behaviours they observed in the classroom. Dorman (2002) suggested that the earliest recorded learning environment research, conducted by Thomas in the 1920s in the USA, used this method of observing and recording.

In the late 1960s, Rudolf Moos and Herbert Walberg independently brought the concept of psychosocial environments into the research arena with Walberg employing students' perceptual data collected by questionnaire. Dorman (2002) concluded that Walberg's work had shown the validity of using summary judgements made by students about their classrooms. He also determined that those perceptions should be used in learning environment research. Indeed, Walberg himself claimed that:

> Students seem quite able to perceive and weigh stimuli and to render predictively valid judgements of the cohesiveness, democracy, goal direction, friction, and other psychological characteristics of the social environment of their classes. (Walberg, 1976, p. 160)

Moos concurred when he stated that:

> Students' perceptions provide an important perspective on educational settings. Information about living groups and classrooms can be obtained by outside observers, who may be more "objective", but it is difficult for such people to know what the setting is like without actually participating in it. Students conversely have time to form accurate, durable impressions of the educational setting's social milieu. (Moos, 1979, p. 21)

In 2004, the Australian Research Council (ARC) undertook funding of a Discovery project entitled 'Improving Assessment in Science through the use of Students' Perceptions' (Chief Investigators: Professor Darrell Fisher, Associate Professor

Bruce Waldrip, and Associate Professor Jeff Dorman). The conceptual framework for the project brought together the three concepts of students' perceptions of their assessment tasks, the students' perceptions of teacher–student interactions in the classroom, and the students' attitude towards science. The concepts were articulated into one survey comprising four sections: demographic information; the students' perceptions of assessment; the students' perceptions of the learning environment; and the students' attitude to science. The questionnaire relies on students self-reporting their perceptions. This thesis reports some of the data collected.

1.2.1 Assessment Tasks

To measure the students' perceptions of assessment tasks in the middle school years in science classes, relevant parts of the *Perceptions of Assessment* questionnaire [PAT(MS)] developed by Schaffner, Burry-Stock, Cho, Boney, and Hamilton (2001) were used in conjunction with material from the *Student Learning Preferences* questionnaire (Gough, Waldrip, Tytler, Beeson, & Sharpley, 2002). The result is a 30-item instrument measuring congruence and planned learning, authenticity, student consultation, transparency, and diversity. This section is entitled *Students' Perceptions of Assessment Questionnaire* (SPAQ*).* It forms the second section of the survey.

Whilst the perceptions of assessment task information provided by respondents to the SPAQ is not an integral part of the current research it is interesting to note that student input into the assessment process is being increasingly advocated by educational researchers. The historical 'production line' concept of education where the student is the passive receiver of information that is then regurgitated during assessment is being questioned. This requires a fundamental review of how teachers involve students in assessment tasks (Rogoff, 2001).

1.2.2 Learning Environment

In the years since the mid 1960s, a number of instruments have been developed to assess learning environments from the perspective of those participating rather than observing. These instruments included the *Learning Environment Inventory* (LEI)

(Fraser, Anderson, & Walberg, 1982), and the *Classroom Environment Scale* (CES) (Moos & Trickett, 1987). Instruments were also developed for a number of specific contexts such as individualised classrooms, computer-assisted instructional settings, for primary school level, and for higher education (Kim, Fisher, & Fraser, 2000).

Drawing on experience gained from the use of earlier instruments, the *What Is Happening In the Classroom* (WIHIC) questionnaire was developed in 1996 by Fraser, Fisher, and McRobbie. The WIHIC brought together selected scales from the earlier instruments and new scales relevant to contemporary educational situations (Aldridge & Fraser, 1997; Rickards, den Brok, Bull, & Fisher, 2003). The WIHIC has also been adapted for use in Taiwan, Singapore, and Brunei, and for a variety of subjects such as geography, mathematics, science, and computing (Margianti, 2003).

Relevant elements from the WIHIC questionnaire were used to form section three of the questionnaire. The 25 items measure student perceptions of cohesiveness, teacher support, involvement, task orientation, and equity in the science classroom.

1.2.3 Attitudes towards Science

Previous research has shown that students' perceptions of their classroom environment are related to attitudes towards science (Fisher & Waldrip, 1999; Klopfer, 1992). In the present study, attitude towards science was assessed by using an adaptation of the *Test of Science Related Attitudes (TOSRA)* (Fraser, 1981) previously employed in a study by Waldrip and Fisher (2000). These questions make up the final section of the instrument and consist of 14 items measuring attitude to science class, and self-efficacy.

1.3 Research Questions

The main purpose of the research described in this thesis was to consider the issue of students' dwindling interest in science at a higher level. Establishing a means of addressing the decline in attitude in a relatively quick and easy way prompted the development of the specific research questions.

Previous research (Fraser & Tobin, 1998; Goh & Fraser, 1998; Waldrip & Fisher, 2003; Wubbels, 1993) identified the important relationship between teacher-student interpersonal relationships and the outcome of attitude in different settings and different subject areas. One of the main areas of influence on attitude was the helpfulness/friendliness of the teacher. This was also identified as a characteristic of an exemplary teacher.

Parts of the aspect of helpfulness/friendliness in the earlier research equate to the Teacher Support scale in the current student questionnaire and this led to the formulation of the first research question:

> 1. Do students' perceptions of teacher support in the learning environment affect their attitude to science classes?

An important part of support from a teacher is that it is given in an unbiased, universal way, e.g., gender neutral. Buck (2001) demonstrated that there is a difference in how girls and boys approach science adding further weight to the findings of Henderson, Fisher, and Fraser (1998). This prompted research question two:

> 2. Do students' perceptions of their equitable treatment within the learning environment affect their attitude to science classes?

Since teacher support and equitable treatment are both components of the teacher–student interpersonal relationship it was necessary to investigate whether they combined to affect students' attitude. Research question three facilitated that:

> 3. Do perceptions of teacher support combine with those of equity to affect students' attitude to science classes?

Because of the gender differences evidenced in earlier studies, the combination of teacher support and equity, and their effect on attitude was investigated separately for males and females to answer the question:

4. Is the teacher support – equity – attitude relationship of the male respondents different from that of the females?

Whilst the focus of the study was the junior high school years of 8, 9, and 10, the students in those years by very definition had differing levels of educational experience – experience that may have affected their perception of teacher support and equity, and their impact on attitude to science. This consideration led to the next research question:

5. Is the teacher support – equity – attitude relationship different between the year groups?

Since teaching practice is determined by adults based on their view of the classroom environment, it was also necessary to establish what those teacher perceptions were. This led to the final research question:

6. How do teachers perceive the science-learning environment, with particular reference to: teacher support, equity in the classroom, students' attitude to science, gender differences, and year group differences.

1.4 Overview of the Research Method

Quantitative data were collected from 1,775 students in years 8, 9, and 10 in Australian schools. The schools were located in Canberra, Queensland, and Western Australia.. The dataset was analysed using the SPSS software package, Version 14 (SPSS Inc., 2005).

Frequency distributions and descriptive statistics were produced to check for any obvious data entry errors and anomalies. Once the data had been cleaned and checked again, Principle Components Factor Analysis was used to confirm the scale structure within the learning environment and attitude sections of the student questionnaire. The internal reliability was checked using the Cronbach Alpha coefficient before taking a mean score across the relevant items in each scale, and creating the new variables of Teacher Support, Equity, and Attitude to Science Classes. Mean scores were taken so that the scoring of the resultant variables would relate to the original coding scheme used on the questionnaire.

The relationship between the scales of Teacher Support and Attitude, and Equity and Attitude was examined using the Pearson's Correlation procedure. Regression analysis was used to examine the contribution of Teacher Support and Equity to the Attitude variable.

Gender differences in each of the scales were examined using Independent Samples *t* Tests while a univariate Analysis of Variance was performed on the scales to test for differences across the three school year groups.

Two high school science teachers were interviewed to get some insight into their perspective on the current state of science education. One teacher from the primary level was also asked for his views, as was a pre-service primary school teacher. A pre-service teacher was included to ascertain what emphasis, if any, was placed on training in the teaching of science at that primary school level. The subjects were interviewed in 2006 and were not from the schools sampled for the quantitative data.

1.5 Significance

The study provides new information about the role of the learning environment, particularly teacher support and equity, in students' attitude to science classes in the important junior high school years – the years when decisions are made about future study and career paths.

Investigation of teacher support and equity in the classroom and their relationship to attitude to science classes provides a particular focus not done before and it is likely to have implications for teacher practice by relating specific teacher actions to student attitudes to science classes. Making teachers aware of the benefits of consciously demonstrating basic classroom etiquette, such as giving support to the students and treating them all equitably, could be a simple, cost effective way of lifting the profile of science. Imparting information may not be enough. The environment that it is given, and the manner in which it is given, however, could make all the difference to the students.

The study forms the basis for exploring the relationship between teacher actions and student reactions in other learning situations, both formal and informal. If the attitude to science is affected significantly by the simple behaviours of support and equity on the part of the teacher, then research should extend into other subject areas. Just as science teaching and learning seem to be at crisis point in the formal education arena, training and developing competencies in the informal/voluntary situation is also at a critical level. It might well be that training of the teachers or trainers needs to include interpersonal skill development as well as knowledge development to help bring about change.

1.6 Overview of the Thesis

The general background for the study, explaining how the questionnaire was developed and setting out the material being used in this current study is found in Chapter 1. The chapter also gives the research questions and a brief explanation of the methodology used to address them, as well as explaining the significance of the study to junior high school science teaching and learning.

The historical background to learning environment research along with summaries of some of the research literature regarding the various aspects of this study – learning environments, perceptions, teacher support, equity, and measuring attitudes are given in Chapter 2. Results of studies are presented and reviewed that relate to these concepts in a variety of subject areas, year groups and nationalities.

A more detailed explanation of the research methodology used to address the research questions is given in Chapter 3.

The results of the analyses performed on the quantitative data to address the first five research questions are given in Chapter 4.

Reports on the interviews held with a pre-service primary school teacher, a current primary school teacher, and two high school science teachers appear in Chapter 5. This qualitative information addressed the final research question.

In the final chapter, Chapter 6, summaries of all the material are presented, along with some conclusions, discussion on the limitations of the study, and suggestions of any implications that the results may have on teaching practice.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

For the past 20 years, I have been involved in a number of teaching situations within a tertiary institution, training situations for a commercial organisation, and training situations in a voluntary community group. All have been in an adult learning environment. The community training has been of adults who are leaders of groups of youth members. At the same time, I have also been working as a leader of youth members myself. It is probably the latter that sparked the interest in the current research area. Why do some youth members blossom more than others? Why are some of the youth groups within the organisation more successful at retaining members than others? What is it about the leader – member relationship that affects the success, or otherwise, of participation? Is there something that the leader can do to increase the success levels, however they are measured?

Within the adult learning arena also, there are a variety of successful outcomes. In terms of tertiary outcomes, passing the examination is the direct measure of success for the student, but a demonstration of enthusiasm for and interest – a positive attitude - in the subject area by the students is a measure of success for the teacher. Why do some students blossom more than other? What is it about the teacher – student relationship that affects the success, or otherwise, of the outcomes? Is there something that the teacher/trainer can do to increase the success levels, however they are measured?

Given that the learning environment is constant for all the participants at the time, the dynamic that is changing is the interpersonal one between teacher and student, between trainer and trainee, between leader and youth member.

Whilst the term *learning environment* could be used to describe anything from classroom or behaviour management through to the physical arrangement of desks or paint colours on walls, the concept of the learning environment here refers to those aspects influenced by human behaviour, namely the atmosphere, the ambience, the tone, or the climate that pervades the particular setting - those things that can affect the outcomes for all concerned (Dorman, Fisher, & Waldrip, 2006).

These same questions and considerations formed the basis of research that is now considered the foundation of much current learning environment research. As early as 1936, Lewin defined behaviour as a function of the person and the environment they find themselves in. Murray proposed a needs-press model that also involved the interaction of person and environment (Fraser, 1998). In later years, Moos and Walberg both examined the impact of the classroom psychosocial environment on learning outcomes (Fraser, 2002), studies that have been developed for different situations in several countries.

A number of aspects of research have been brought together in this study, namely, the use of student perception data, teacher support and equity in the classroom as components of the learning environment, and attitude to science. In this chapter, some of the literature pertaining to each of these aspects is reviewed and described. The chapter concludes with a summary of the findings as they relate to the present study.

2.2 Role of the Teacher

Teaching is the process by which a person helps others to learn (Abraham, 1982). Being one of the most important activities, teaching enables others to gain the knowledge they need to earn a living, to contribute to society, and to shape the future. Teaching and learning is also a way of passing on knowledge from generation to generation to ensure a continuum of progress.

Teaching does not only take place in a formal situation, of course. It happens informally in the home, in the workplace, and by experiencing life generally. The informal teaching, though, often relates to skills and habits rather than factual knowledge. That sort of teaching is more often confined to the more formal environment of the classroom and the professional classroom teacher. According to Abraham, the four main duties of a teacher are:

1. prepare for classes
2. guide or assist the learning of the students
3. check student progress
4. set a good example for their students

and they must do this while trying to “identify and respond to the needs of individual students” (pp. 55-56).

Fielding (2006) asked, and then set out to answer, a number of pertinent questions concerning the heart of teaching and of being a professional teacher. She asked “what aspects of the human condition impact on an individual and define them as an effective, empathetic teacher? Does life experience enhance classroom practice and improve teaching talent?”. She then went on to describe how the classroom behaviour of a particularly aggressive mathematics teacher engendered such a negative impact on her confidence in, and attitude to mathematics. The teacher’s behaviour made her fearful of failure, of being unworthy, of feeling incompetent, and fearful of losing face among her peers. What she really needed was for the teacher to know her, to know that she had missed a lot of schooling due to ill health; that she was not a person who could answer without thinking; and to help her as she endeavoured to answer his questions. That fear of mathematics has endured even though the experience she recounted happened at the age of 11. What the experience did provide, though, was an awareness that needed to be brought into Fielding’s career as a teacher, an awareness of the impact that a teacher’s behaviour can and will have on a student’s attitude to a subject area. Interestingly, though, Fielding described the teacher as “one of (her) best” (p. 185), despite the humiliation she felt in the mathematics class, because there were also many positive aspects to other areas of his teaching practice. Fielding concluded that the teachers were the most important part of the entire education system since they were the deliverers of the education product and provided the learning environment that students responded to.

Equity, or equitable treatment of students in the classroom, is also part of Abraham’s definition of duties of a teacher – setting a good example for students. Approaching everyone on the same basis, regardless of race, creed, gender, ability, socio-economic status, or anything else, is part of the consideration of feelings that are crucial to social stability and human wellbeing. It could also be considered as an extension to the practice of being a supportive, empathetic teacher.

Each learner brings to the endeavour their own style, ability, set of expectations, and level of success. Zyngier (2005) argued that it was important to assist pre-service teachers to understand the need to recognise and engage with student differences in a supportive classroom in order to maximise student outcomes. Whilst the comments were expressed in support of the use of Productive Pedagogy, the point was made on several occasions that good teachers recognise that students learn in different ways and have different needs. Research has often shown that girls perceive situations differently to boys, that children from a low socio-economic background respond differently to those from a higher one, and that cultural differences bring a variety of educational expectations and outcomes. The role of the teacher is to provide an environment that allows for the needs of everyone, especially in multi-cultural, co-educational systems such as in Australia. Being aware of the needs of individual students; being aware of the characteristics that set them apart from other students; recognising that, whilst every student has the right to be individual, they all have the right to be treated equally is a characteristic of a good teacher. A good teacher will provide a good learning environment and results of studies over the past 30 years have shown that the quality of the classroom environment has a significant effect on student outcomes (Fraser, 1998). It is apparent that what is important for learners is a teacher who is supportive and provides an equitable environment for the students.

2.3 Learning Environment Research History

In his introduction to the inaugural edition of the journal *Learning Environment Research* in 1998, Fraser said that "a milestone in the historical development of the field of learning environments…" (p. 1) was the work done independently by Herbert Walberg and Rudolph Moos in the 1960s. Whilst they are a 'milestone', their work had built on that done much earlier by Lewin and then Murray.

Learning environments research can be traced back to the formula Lewin espoused in 1936 of $B=f\{P, E\}$. Lewin noted, "every scientific psychology must take into account whole situations, i.e., the state of both person and environment" (1936, p. 12). Thus behaviour (B) is expressed as a function (*f*) of person (P) and environment (E). Murray (1938) developed the notion of studying the individual's behaviours at that moment in time, as expressed by Lewin's formula, to one of considering the attributes of what *press* is applied to influence that behaviour. He used the terms alpha press and beta press to distinguish between external influences observed by a detached third party (alpha press) and perceptions of the environment experienced by the individual participant (beta press) (Dorman, 2002). Murray believed that beta press exerted the greater influence on behaviour because that was what was felt, interpreted and responded to by the person (Hjelle & Ziegler, 1981, cited in Dorman, 2002).

In 1956, Stern, Stein, and Bloom took the beta press concept one step further by suggesting the further distinction of *private* beta press and *consensual* or *common* beta press (cited in Saunders & Fisher, 2006). They put forward the idea that each person had their own subjective perception of the environment (private beta press) but that there was also their shared view as a member of a group about that same environment (consensual beta press) (Walker, 2004).

The types of research done over the years fall into the two broad categories of low-inference and high-inference. Dorman (2002), citing Rosenshine (1970), defined low-inference measures as a system recorded by observers of the number of times a particular behaviour occurred in the learning environment. This typically equated to alpha press. High-inference measures, however, require the participant to relate their perceptions of behaviours during a specific event (for example, a particular learning situation). This typically equated to (private) beta press. Dorman goes on to say:

> While some historical research involved low inference measures using a detached observer, the overwhelming methodological tradition is high inference beta press. In fact, few genuine learning environment studies over the past 20 years have departed from the use of inhabitants' summary judgements of the environment. Indeed, the use of student perceptual data is considered essential to contemporary classroom environment research. (p. 4)

Walberg suggested that Lewin's psychological formula to explain behaviour be adopted and adapted for the education situation to L = *f* (A, T, E) where learning (L) is a function (*f*) of the individual's aptitude (A), the instructional treatment (T), and factors of the environment (E) (Walberg, 1981, cited in Walker, 2004). Figure 2.1 shows, schematically, that theory of educational productivity (Walberg, 1981, 1984, cited in Henderson et al., 1998) as it relates to aspects of the formula.

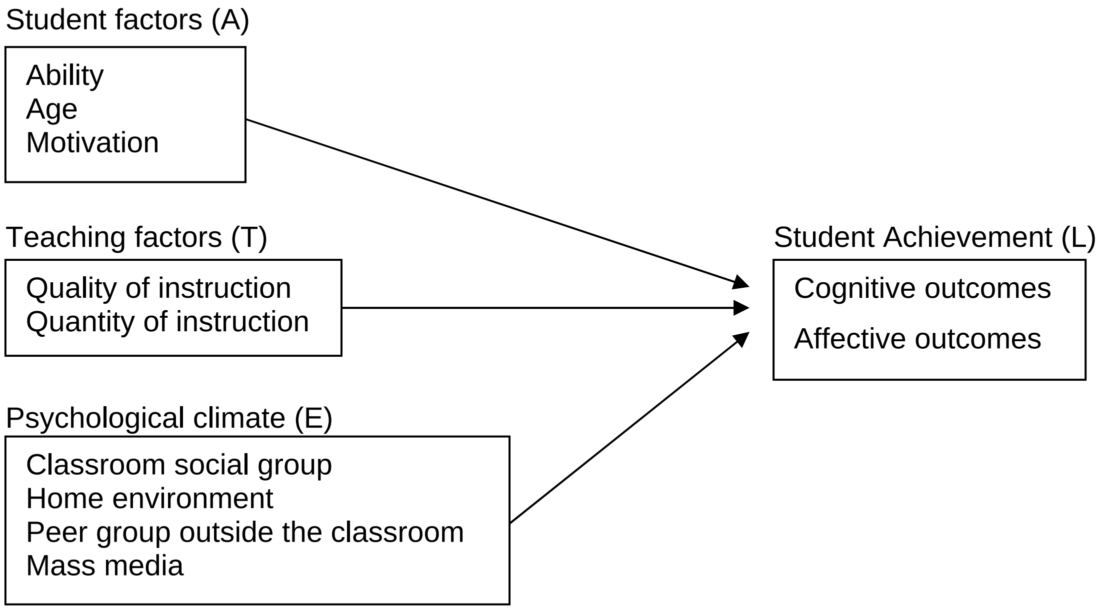

Figure 2.1. Schematic representation of Walberg's theory of educational productivity.

Moos' interest in and early work with psychological and sociological environmental phenomena led to his development of a perspective that was designed to help with the understanding of how psychosocial environments influenced an individual. He defined the three components as: the Relationship Dimension, the Personal Growth Dimension, and the Systems Maintenance and Change Dimension. The Relationship Dimension identified the nature and strength of personal relationships. It assessed the extent to which people were involved in the environment and support and help each other (Moos, 1974). The Personal Development Dimension identified personal growth and self-enhancement opportunities offered by the environment (Walker, 2004). The Systems Maintenance and Change Dimension was concerned with the extent to which the environment was orderly, clear in expectations, and responsive to change (Fraser, 1998).

Using these dimensions as a basis for exploring and explaining participants' involvement in environments such as the classroom, gave the potential for change and development of the environment. This in turn facilitated more research to assess those developments and suggest further changes to enhance the lives of those participating in the environment (Walker, 2004).

In the context of this current research, high inference private beta press measures have been used to investigate the affect of Teacher Support, as part of what Moos called the Relationship Dimension, and Equity, from the System Maintenance and Change Dimension, on the affective student achievement of attitude to science. Walberg (1976) and Moos (1987) were both advocates of the use of student perceptual responses in educational research since students spend so much time immersed in the learning environment. Indeed, in a graduation speech delivered in Indonesia, Fraser (2001) spoke about students' perceptions of the importance of the learning environment. He explained that students could amass as much as 20,000 hours of education by the time they complete university studies so are well placed to make 'judgements … because they have experienced many different learning environments and have had enough time in class to form accurate opinions' (p. 2).

2.4 Use of Student Perception Data through Questionnaires

A convenient and inexpensive way to measure student perceptions of the learning environment is through the use of questionnaires that can be processed quickly and easily, typically via computer software. In 1932, Likert made use of an attitude test that he developed for his doctoral studies. His "Survey of Opinions" required respondents to nominate their opinion by using a three or 5-point category scale and provided the foundation for the development of perception questionnaires and the use of quantitative data (cited in Scott, 2001).

In 1998, Fraser described as 'historically important and contemporary instruments' (p. 9) the *Learning Environment Inventory* (LEI) (Walberg & Anderson, 1968);

Classroom Environment Scales (CES) (Moos & Trickett, 1987); *Individualised Classroom Environment Questionnaire* (ICEQ) (Rentoul & Fraser, 1979); *My Class Inventory* (MCI) (Fisher & Fraser, 1981); *College and University Classroom Environment Inventory* (CUCEI) (Fraser, Treagust, & Dennis, 1986); *Questionnaire on Teacher Interaction* (QTI) (Créton, Hermans, & Wubbels, 1990); *Science Laboratory Environment Inventory* (SLEI) (Fraser, McRobbie, & Giddings, 1993); *Constructivist Learning Environment Survey* (CLES) (Taylor, Dawson, & Fraser, 1995) and *What Is Happening In this Class* (WIHIC) questionnaire (Fraser, Fisher, & McRobbie, 1996).

Walberg developed the *Learning Environment Inventory* (LEI) in the late 1960s, initially as part of the research related to Harvard Project Physics. The final version contained 105 statements covering the 15 scales of: Cohesiveness, Diversity, Formality, Speed, Material Environment, Friction, Goal Direction, Favouritism, Difficulty, Apathy, Democracy, Cliqueness, Satisfaction, Disorganisation, and Competitiveness. Each item had the response alternatives measured on the 4-point Likert-type scale of Strongly Disagree, Disagree, Agree, and Strongly Agree (Fraser, 1998).

Moos' work included the development of various social climate scales including the *Classroom Environment Scale* (CES) that, in the final published version, contained nine 10-item scales measuring Involvement, Affiliation, Teacher Support, Task Orientation, Competition, Order and Organisation, Rule Clarity, Teacher Control, and Innovation. The response format for each item was True / False (Fraser 1998).

Whilst these two instruments led the way in quantitative data constructs, the two instruments most influential in the current research are the *What Is Happening In this Classroom* (WIHIC) questionnaire and the *Test Of Science Related Attitudes* (TOSRA; Fraser, 1981). Adaptations of scales from these two instruments were used to form the learning environment section and attitude section, respectively, of the current student questionnaire given in Appendix A.

The original 90-item version of the WIHIC instrument covered nine scales by combining modified versions of the most relevant scales from a range of existing questionnaires with scales measuring the contemporary aspects of equity and constructivism. It was administered to 355 junior high school students and the results, coupled with extensive interviewing about learning environments in general and comments on the wording used in the instrument, brought about a change to the structure. Further testing and modification led to a final form of the WIHIC containing seven eight-item scales with each item being responded to on a 5-point Likert-type scale of Almost Never, Seldom, Sometimes, Often, Almost Always. The seven scales were Student Cohesiveness, Teacher Support, and Involvement from the Relationship Dimension; Investigation, Task Orientation, and Cooperation from the Personal Development Dimension: and Equity from the Systems Maintenance and Change Dimension (Fraser, 1998). For the present study, the decision was made by the ARC Chief Investigators to use only five of the scales (Student Cohesiveness, Teacher Support, Involvement, Task Orientation, and Equity) and to reduce each one from eight items to five. The response format was also reduced to Almost Never, Sometimes, Often, and Almost Always (Dorman, Fisher, & Waldrip, 2006) to encourage respondents to make a definite decision when responding to a statement, rather than taking the (approximately) neutral mid-point.

Many of these questionnaires are available in two forms: the Actual and Preferred or Ideal. Whereas the Actual form measures the learning environment as perceived by students, the Preferred or Ideal form is concerned with goals and value orientations. It measures perceptions of the classroom environment ideally liked or preferred (Fraser, 1998). Importantly, learning environments research, which has adopted a person-environment fit perspective (Hunt, 1975) has revealed that the similarity between the actual environment and that preferred by students leads to improved student achievement and attitudes (Fisher & Fraser, 1983, Fraser & Fisher, 1983a, 1983b).

2.5 Learning Environment Studies using the WIHIC Instrument

Using quantitative and qualitative data, a study of science classroom environments in Taiwan and Australia (Aldridge & Fraser, 1997) was reported as one of the few cross-national studies ever undertaken in education at that time. The WIHIC was translated into Chinese by team members based in Taiwan and both the Chinese and

English versions were checked for readability and comprehensibility before the final 70-item instrument was administered to 1,081 Western Australian grade 8 and 9 students, and 1,879, grade 7-9 students in Taiwan. The instrument also included 8-item attitude scale based on a scale from the TOSRA. Factor analysis with Varimax rotation resulted in the 70 items being reduced to 56 items (eight items in each of the seven scales) for ongoing analysis. The alpha reliability for Teacher Support, and Equity for both counties was 0.87 or above indicating strong constructs for both situations. Each item had a 5-point Likert-style response format with ‘Almost Never’ scored 1 and ‘Almost Always’ scored 5. Comparison of the scale means showed that the Australian students perceived Teacher Support, and Equity, more favourably than their Taiwanese counterparts but the Australian student’s attitude to science class was lower than that of the Chinese students. The difference between the two groups on Equity, and Attitude were statistically significant (p<0.05). The qualitative data were used to explain these differences and the researchers came to the conclusion that using mixed methods provided more insight and better explanations of their findings.

Another study to use and validate the WIHIC and QTI in an international setting was that conducted by Kim, Fisher, and Fraser (2000) where they examined the classroom environment and teacher interpersonal behaviour in secondary science classes in Korea. The two questionnaires, along with the Attitude to Science Class scale from the TOSRA, were translated into Korean and then administered to 543 Grade eight students in 12 different secondary schools in metropolitan, small city, and rural areas of Korea. The alpha reliability score of 0.87 and 0.92 for the WIHIC scales of Teacher Support and Equity, respectively, were very similar to those reported by Aldridge et al. (1997) in the Australia/Taiwan study. The QTI scale of Helping/Friendly also showed high internal consistency with an alpha reliability of 0.83. The seven 10-item WIHIC scales were scored on a 5-point format with Almost Never being scored 1 and Almost Always being scored 5. The QTI scales were also scored according to a 5-point format with 0 representing Never, and 4 representing Always. As with the Taiwanese study, the mean score for Teacher Support was lower than other WIHIC scales, while Equity was mid range. The mean score for Helping/Friendly was third highest among the QTI scales. Comparisons of the male and female data showed significant difference (p<0.001) between the sexes on

Teacher Support, Equity, and Helping/Friendly with males consistently reporting more favourably. This is in direct contrast to other studies where girls have responded more positively (Fraser, McRobbie, & Giddings, 1993). The boys also showed a more favourable and statistically significantly different ($p<0.001$) attitude towards their science classes than the girls. Teacher Support, Equity, and Helping/Friendly were all significantly and positively correlated ($p<0.001$) with the students' attitude towards science with the beta weights (β) showing that the two WIHIC scales were significantly and independently associated with attitude.

Whilst there have been many international uses of the WIHIC, most have concentrated on the perceptions of the students within their own environment. One exception to this was a study reported in 2001 by Khine and Fisher that examined the science classroom environment and the influence on it of teachers' cultural background. In Brunei, at that time, expatriate teachers from Australia, New Zealand, and the United Kingdom were often employed to fill the gap left by a shortage of local science teachers. Using the seven WIHIC scales, and the two TOSRA scales of Attitude to Science Inquiry, and Enjoyment of Science Lessons, the study compared the responses of students with teachers from an Asian culture with those of students exposed to teachers from a Western culture. The questionnaire was administered to 1,188 male and female students in Form 5 (Grade 11) of 10 government secondary schools. The alpha reliability was reported as 0.80 for the Teacher Support scale and 0.85 for the Equity scale. All of the seven WIHIC scales were significantly and positively correlated to Enjoyment of Science Lessons ($p<0.01$). A multiple correlation analysis ($R=0.44$) showed that the nature of the classroom environment strongly influenced the students' enjoyment of their science lessons. The standardised regression coefficient (β) also showed that Teacher Support, and Equity were two of the four significant predictors of the students' enjoyment. The study had been conducted in 54 science classes and involved 47 teachers, 24 from an Asian cultural background and 23 with a Western background. *t* tests used to compare the two backgrounds showed a statistically significant difference ($p<0.001$) for Teacher Support, Equity, and Enjoyment of Science Lessons with students whose teacher had a Western background responding more favourably. Khine and Fisher concluded that "teachers from different cultural backgrounds created different types of learning environment" (p. 17) because of how different cultures perceive the role of the teacher. They also concluded that, from this study, each culture could learn from the other about teaching and classroom management.

In 2002, Wallace, Venville, and Chou took the use of the WIHIC in a slightly different direction. A 70-item version of the questionnaire was administered to all the students in a Year 8 science class in a large, metropolitan government, co-educational school in Western Australia. The response format for each item ranged from Almost Never, scored 1, to Almost Always, scored 5. Three items from each of the Teacher Support, Involvement, Cooperation, and Equity scales were then selected as the basis for separate interviews with four students from the class. The results from the four students were compared to the class means for the same items to compare their perceived placement in the learning environment to the overall perceptions of the class. For three of the four scales, the two female students scored above the class mean and the two males below. Perhaps more importantly, the four students and their teacher were asked about the content of the items themselves and what they thought they meant. This raised interesting issues of differences of interpretation of the wording ranging from not understanding but being prepared to guess at the meaning, through to positive and negative interpretations of the same item. The teacher also seemed to address some items in yet another way with views affected by his role in the class rather than just another participant in the environment. The analysis results from both the quantitative and qualitative data revealed a mixed picture with the authors concluding that a learning environment is a 'complex phenomenon' (p. 151) and that whilst the use of well considered questionnaires will 'offer some insights into the collective experiences of the members of the classroom' (p. 151), there is no substitute for probing the individual student's experiences. Only in this way can researchers understand the variety of interpretations of, and thus responses to, standard, validated instruments perhaps prompting a review of the methodologies.

The versatility of the WIHIC was demonstrated by Allen and Fraser (2002) when it was adapted and used to examine both parent and student perceptions of the classroom learning environment and its influence on student outcomes in South Florida, USA. For both groups, the questionnaire was used in its Actual and Preferred formats. The number of items was reduced from 56 to 39 to increase the suitability for 9-11 year olds. The parent version reflected the modified student one. The scales used were Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, and Equity. A modified version of the TOSRA was used to measure Attitude to Scientific Inquiry, and Enjoyment of Science Lessons. Factor analysis was performed on data for the four questionnaires but the results obtained for the parent version were not as strong as those for the students. This could be explained by the relatively small sample size for the parents (N=120). Despite this, the alpha reliabilities for all scales on the Actual form of the questionnaire for both groups were high (0.67 to 0.86 for the student data, 0.77 to 0.89 for the parent data). Comparisons of the parents' preferred and the students' preferred levels of both Teacher Support, and Equity showed that the parents prefer significantly higher levels than the students ($p<0.01$). For this group of students, neither Teacher Support nor Equity was correlated with their enjoyment of science lessons. The parent data gave similar results. The study confirmed that the WIHIC demonstrated satisfactory reliability for students and parents, paving the way for the inclusion of parents' perceptions in the area of classroom environment research.

A study conducted by Rickards, den Brok, Bull, and Fisher (2003) used the WIHIC to examine Californian students' perceptions of their multicultural classroom environment. The full version of the instrument was used, i.e. seven 8-item scales with each item measured on a 5-point Likert-type range. Data were initially collected from 1,720 students but complete responses were only available for 665 students so this was the eventual sample size for the study. The students were from 26 grade eight science classes in 11 Californian schools. The study was conducted both within the student body and teaching staff. Apart from the learning environment scale information, other information such as ethnicity, gender, racial diversity, ethnic origins, and socio-economic status were recorded for comparative purposes. The study reported high alpha reliability coefficients for all seven WIHIC scales with Teacher Support and Equity both giving the highest at 0.89 for the student data. The study also reported that the Teacher Support and Equity scales were 'most sensitive for indicating differences between classes.' (p. 18). Female students gave a statistically significantly higher rating than the male students for Teacher Support, but no gender difference was reported for Equity. Contrary to other studies using different forms of analysis, this one found that girls had a more favourable perception of their science learning environment than the boys in terms of the WIHIC scales.

Whilst the WIHIC has often been used with attitude scales to measure the influence of such things as teacher support and equity on the students' attitude to their particular class, Dorman and Ferguson (2004) used it in relation to the students' attitude to their own ability displayed through self-handicapping in mathematics. Self-handicapping is where a person (student) deliberately creates a situation that would provide an excuse for failure (e.g., no time to study because of a family crisis) but allows them to personally take all the credit for success (e.g., got a good mark anyway because I'm smart and didn't need to study). The study used 2,006 students from nine Australian and four Canadian high schools. Australian students from Grades 8, 10, and 12 and Canadian students from Grades 9 and 10 participated. A seven scale 42-item version of the WIHIC was used along with 18-items from three CLES scales. Self-handicapping was assessed by use of a modified version of a 6-item scale developed originally by Urdan, Midgley and Anderman in 1998 (cited in Dorman & Ferguson). The WIHIC and CLES items were all measured on a 5-point Likert type scale from Almost Never, scored 1, to Almost Always, scored 5. The self-handicapping items had a 9-point response format where 0 represented Not at all True and 8 represented Very True. Cronbach's Alpha reliability showed that all scales had a strong internal consistency with Alpha scores ranging from 0.76 to 0.90. Correlational analysis between the environment scales and the self-handicapping scale showed that the majority were significantly and negatively correlated overall, by gender, and by country. This meant that higher scores in the environment scales were associated with reduced levels of self-handicapping – as students perceptions of their learning environment become more positive their apparent need for self-handicapping decreased. This result showed that there was no difference between males and females, or between Australia and Canada.

Using the WIHIC, QTI, and an already existing (but not specified) attitude scale, Koul and Fisher (2006) conducted a study of 1,021 students in 32 science classes in seven co-educational private schools in Jammu, India, to explore the nature of classroom environments and student-teacher interactions. The 48-item version of the QTI measured the students' perceptions of their interactions with their teachers, while the 56-item WIHIC measured students' perception of their classroom environment. The attitude scale comprised eight items and measured students' attitudes towards their science classroom. The three instruments were administered as one questionnaire and all the items were given a 5-point response format with the higher number representing a more positive response to the item. The QTI Helping/Friendly scale gave a lower Cronbach's Alpha than the comparable Teacher Support scale from the WIHIC, 0.65 and 0.78 respectively. The alpha reliability for the WIHIC Equity scale was reported as 0.83 showing that all three scales had a relatively high internal reliability for this sample of students. The alpha reliability was not given for the Attitude scale. The standardised regression coefficient (β) showed that the QTI scale of Helping/Friendly was one of only two scales that were significantly related to attitude to science ($p<0.01$). From the WIHIC scales, Equity was one of only three significant, independent, predictors of attitude ($p<0.01$). t tests showed a significant difference between males and females ($p<0.001$) in relation to the Helping/Friendly and Equity scales with females perceiving a more positive situation than the males. The study also examined differences between the cultural backgrounds, and the different religious faiths represented in the student body. Statistically significant differences were reported in the former but not the latter.

Perceptions of the classroom environment, established through use of the WIHIC, were tested against students' sociometric status in a study completed by Parish and Fisher (2006). Sociometric testing requires students to choose which other students they would prefer to work or associate with. Using the *Peer Nomination Method* (PNM), 1,021 year 9 students from 8 rural and urban secondary schools in New Zealand wrote down the names of three students they most favoured. They also completed the WIHIC questionnaire. Using defined procedures, the nomination totals for each student were used to calculate their sociometric status group membership. The reliability of the scales was determined by the test-retest reliability method with all results being at a satisfactory level. The eight items in each of the seven WIHIC scales used a 5-point response format of Almost Never, scored 1, to Almost Always, scored 5. The Cronbach alpha coefficient confirmed the reliability of all scales with the highest alphas being reported for Equity (0.92) and Teacher Support (0.90). One-way Analysis of Variance was used to test for differences in the classroom environment scales between the various sociometric groups. The results showed that the popular status group perceived, on average, the environment as measured by the WIHIC more positively than the other groups. The popular group was significantly different to the rejected and controversial groups ($p<0.001$) in their perception of equity, and also different to the controversial group ($p<0.05$) in their perception of teacher support. The rejected and controversial sociometric status groups perceived the classroom more negatively on all aspects. The authors concluded that sociometric status significantly influences a student's perception of the classroom environment.

Showing a diversity of applications for the information obtained from use of the WIHIC questionnaire, Saunders and Fisher (2006) used a shortened form of it to help three pre-service teachers in New Zealand examine and improve upon what was happening in their science education classes. Because the study was done with primary school children, the instrument was simplified in language and content to make it appropriate for the age level. Five 5-item scales (Student Cohesiveness, Teacher Support, Involvement, Task Orientation, and Equity) were used with each item given a 4-point Likert-style response format from Almost Never, scored 1 to Almost Always, scored 4. The research design for the study was that of action research with the WIHIC being administered three times over a period five weeks. Initially the questionnaire was used in both its Actual and Preferred forms allowing the pre-service teachers to examine discrepancies between the two and implement strategies for change. The data showed there was a difference between the children's perception of their actual and preferred environment with the actual scoring less than the preferred on all scales for each of the pre-service teachers. At the end of the five weeks, during which the pre-service teachers had been able to make changes to their classroom approaches, the Actual form of the WIHIC was administered again. For all scales for each teacher, there was a reduction in the Actual-Preferred differences.

Using the data drawn from the same source as for this thesis, Dorman, Fisher, and Waldrip (2006) used a LISREL analysis to study links between students' perceptions of learning environments and assessment with academic efficacy and attitude to science. Since the students were being asked to reflect on four facets of classroom life, namely classroom environment, perceptions of assessment, academic efficacy, and attitude to science, the WIHIC usage was reduced from seven to five scales with each item using a 4-point response format of Almost Never (1) to Almost Always

(4). The Students' Perceptions of Assessment Questionnaire (SPAQ) used 30 items in five scales with each item measured in the same way as the WIHIC items. The 14 items measuring science attitudes were also measured on a 4-point scale and were an adaptation of scales from the TOSRA. The authors chose to construct the Academic Efficacy scale from six items and the Attitude to Science from eight items, unlike the scales for this thesis, which placed seven items in each scale. The data for this analysis came from 449 Year 8, 9 and 10 students in Queensland. The alpha reliability for each of the 12 scales showed at least a satisfactory internal consistency with indices ranging from 0.66 to 0.90. Specifically, Teacher Support was 0.87, Equity was 0.88, and Attitude to Science was the highest with 0.90. Multiple regression analyses showed that Teacher Support and Equity were both significant ($p<0.05$) predictors of Attitude to Science. The final model from the LISREL analysis showed that whilst the direct effect of Teacher Support on Attitude to Science (β) was 0.25, this increased to 0.30 when the indirect effect via Congruence with Planned Learning, and Academic Efficacy were included. Equity gave a direct β value of 0.20 ($p<0.05$) on Attitude to Science with no indirect loadings. Whilst all the SPAQ dimensions were shown to affect academic efficacy, the only SPAQ scale to have a direct effect on Attitude to Science was Congruence with Planned Learning. The other scales had an indirect effect via Efficacy. This led to the conclusion that though the classroom environment has repeatedly been found to influence attitudinal outcomes, assessment is such an integral part of that environment that it has a mediating effect and should be considered in any changes made to enhance students' attitude to science.

2.6 Other Relevant Studies

Within Moos' Relationship dimension, two other instruments include a scale that is comparable with the Teacher Support scale of the WIHIC. The CES includes a Teacher Support scale while the scale within the QTI is known as Helping/Friendly. Table 2.1 displays the items making up those scales in each instrument. A sample of studies using these scales is reviewed below but since the WIHIC was the first instrument to include an Equity scale there are no comparable studies for that.

Table 2.1.

Items in the Teacher Support and Helpful/Friendly Scales

Teacher Support scale within CES	Helping/Friendly scale within QTI (Australian version)
This teacher spends very little time just talking with students.	This teacher helps us with our work.
The teacher takes a personal interest in students.	This teacher is friendly.
The teacher is more like a friend than an authority.	This teacher is someone we can depend on.
The teacher goes out of his/her way to help students.	This teacher has a sense of humour.
Sometimes the teacher embarrasses students for not knowing the right answer.	This teacher can take a joke.
This teacher ‘talks down’ to students.	This teacher’s class is pleasant.
If the students want to talk about something, this teacher will find time to do it.	
This teacher wants to know what students themselves want to learn about.	
This teacher does not trust students.	
Students have to watch what they say in this class.	

In 1993, Wubbels wrote about research findings in relation to the interpersonal relationships between science and mathematics teachers and their students conducted in two separate studies, one in Australia and one in The Netherlands. Whilst the purposes of the two studies were slightly different, they both used the short 48-item form of the QTI, which was administered to both the students and their teachers. In Australia there were 792 students and 46 teachers while the Dutch study used data from 1,105 students and 66 teachers. The questionnaire used a 5-point response format numbered from 0-4 representing Never and Always at the extremes. The Australian study set out to look at the differences between the students’ perceptions of the behaviours of their science and mathematics teachers and their best teachers. The teachers were also asked to rate their actual behaviours and those they would like to display. The Dutch study investigated relationships between interpersonal teacher behaviour and student achievement in and attitude to science. Teachers were also asked to report their perceptions of their interpersonal behaviour. The alpha reliability for the Helping/Friendly scale for both the students and the teachers in both countries was 0.78 or above and was the highest of all the eight scales within the QTI. The studies found that interpersonal teacher behaviours, of which Helping/Friendly is one scale, is an important aspect of the learning environment in that it is strongly related to positive student outcomes.

Described as the first use of the QTI in secondary science classes in Singapore, Fisher, Goh, and Rickards (1996) examined the perceptions of interpersonal teacher behaviour in secondary science classrooms in Singapore and Australia. They found that, generally, the dimensions of the QTI were found to be significantly associated with student attitude scores. The authors concluded that since students' attitude to science scored more highly where they also perceived higher levels of teacher support, teachers should ensure the presence of this interpersonal behaviour in order to improve attitudes to science. The results came from data collected from 720 grades 8 and 9 students in Singapore, and 705 grades 8 and 9 students in Australia. All students completed the Australian 48-item version of the QTI while the teachers completed the Actual and Ideal versions of the instrument. Both countries indicated a significant relationship ($p<0.05$) between all eight QTI scales and attitude. In classes where the students perceived greater Helping/Friendly teacher behaviour, there was a more favourable attitude towards the science class. Australian students perceived more Helping/Friendly behaviours than their Singaporean counterparts. Examination of the students' perceptions of the teachers' behaviours and the teachers' perceptions of their own behaviours showed differences in the Singapore data but similarities in the Australian data. The Singapore teachers perceived their actual interpersonal behaviours to be close to their ideal while the students' perceived lower levels of Helping/Friendly behaviour than the teachers. The Australian teachers rated their demonstrated level of Helping/Friendly behaviour to be lower than their ideal level would be. The students' perceptions of all the interpersonal behaviours were similar to those of the teachers.

Continuing along a similar line of research, Fisher and Rickards (1996) also used the QTI to examine students' perceptions of teacher-student interpersonal behaviour in relation to attitude, but this time with attitude to mathematics. Again the 48-item Australian version of the instrument was administered to students while the teachers completed Actual and Ideal versions of the same questionnaire. The study involved 405 students in grades 8, 9 and 10 and their 21 teachers in mathematics classes in Australia. The students' attitude to mathematics was assessed with a 7-item scale based on the TOSRA. The alpha reliabilities for the eight QTI scales showed high levels of internal consistency with the coefficients ranging from 0.62 for Strict to 0.88 for Helping/Friendly. Simple correlations between Attitude and each of the QTI scales were significant (p<0.01) with Helping/Friendly being the strongest (r=0.64). The correlation was also positive indicating that more favourable perceptions of the Helping/Friendly teacher behaviour were related to a more favourable attitude to mathematics. The standardised regression coefficient (β) of 0.19 was also significant (p<0.05). The information provided by the analysis of the Actual versus Ideal questionnaires for each teacher along with perceptions of their students, gave teachers the opportunity to self-reflect on their teaching performance knowing that their behaviours were significant predictors of the students' attitude to mathematics.

Concentrating on a cohort of students that had been identified as vulnerable to academic/school failure (Waxman & Huang, 1998), a study of 13,502 students from 60 elementary schools, 28 middle schools, and 8 high schools in the south central region of the USA was conducted to investigate student gender, subject area and grade level differences in perceptions of their learning environment. The study defined elementary students as Grades 3-5, middle school students as Grades 6-8, and high school students as Grades 9-12. The definition of middle school in the USA context does not correspond directly with the definition used for this thesis of Grades 8-10. The study included a modified version of the Classroom Environment Scale (CES). In its original form, the items within the CES had a response format of True-False (Fraser, 1998) but this appears, but not explicitly stated, to have been modified to Agree-Disagree, and the number of items in each of the nine scales reduced. The Teacher Support scale used contained three items out of the original 10 and measured the extent to which the teacher helps students and takes a personal interest in them. Using correlations and multi-variate analysis of variance, the study found that middle school students received less support from their teacher than elementary or high school students, and that the mean score for Teacher Support was lower in middle and high school students than all other scales measured. The study also reported that, generally, female students perceived a more positive learning environment than the males but did not report on specific scales.

Whilst the majority of studies in the field of learning environments have employed quantitative data collection, in 1998 Tobin and Fraser used both quantitative and qualitative methods and explored the use and appropriateness of both for different 'grain size' research. The term 'grain size' was used to describe the intensity of the data collection and comparisons. Information from a very small number of people (in this particular study one classroom teacher, and, separately, a small group of students from her class) requiring a comprehensive, qualitative approach demonstrated a fine grain approach. A large-scale quantitative approach (514 students in multiple schools and classes in this study) demonstrated a coarse grain size methodology. The quantitative data was collected via the CLES with the two purpose-written scales of Teacher Support and Commitment added. Whilst details were not given of the individual items in the scale, the description for the Teacher Support scale was given as 'Helpfulness and friendliness of the teacher towards the student' with a sample item of 'The teacher goes out of his/her way to help me' (p. 630). The items all had a 5-point response format of Almost Always, Often, Sometimes, Seldom, and Never. The analysis off the different grain sizes and comparison of the results (both qualitative observation and quantitative data) showed that the students of the one particular teacher perceived the level of teacher support to be much higher (21 vs. 17 on an additive scale) more highly than for the other teachers. This was explained from the independent observations made of the teacher by the fact that she could relate to the students because of her own personal background. She had come from a very large family, was not a motivated learner, and was aware that students' social problems affected students. As a result of this personal experience she went out of her way to demonstrate behaviours that would have a positive impact on the students and their affective outcomes of higher self-esteem and self-confidence.

In a longitudinal study conducted to investigate changes in learning environment perceptions during the transition from primary to secondary schools, Ferguson and

Fraser (1999) used a modified form of the QTI to assess changes in teacher - student interaction scales. The study was conducted firstly in the November of the final primary school year and then repeated using the same cohort in the May of the first year of secondary school. The sample comprised of 1,040 students drawn from a variety of schools in Tasmania, Australia. In its original form, the QTI responses were given on a 5-point scale ranging from Never to Always (Fraser, 1998), with each of the eight scales containing 8-10 items. For this study, the researchers used six items per scale with a response format of Yes/No for each one. Positive responses were coded three, while negative responses were coded one. Reliability analysis showed that all QTI scales had a high alpha coefficient with Helpful/Friendly being the highest both at the primary and secondary stages (0.81 and 0.85 respectively). A repeated-measures multivariate analysis of variance (MANOVA) showed that there was a significant difference in the Helpful/Friendly scale across the transition ($p<0.01$) and that the interaction effect of gender was also significant at the same level. Examination of the differences between primary and secondary results revealed a drop in the perceived level of Secondary teachers' helpfulness/friendliness compared to Primary teachers and that girls reported less reduction in Helpful/Friendly behaviours than the boys.

Also using the QTI, Waldrip and Fisher (2003) set out to identify and describe characteristics of exemplary science teachers. Citing a number of studies that had described the state of science education across all school levels and across many countries as 'disappointing' (p. 158), the authors stated that it was '…important to investigate what is occurring in science classrooms to provide a focus for improving the situation' (p. 158). In 1996 the Standards Council of the Teaching Profession of Victoria (cited in Waldrip & Fisher) set out five generic dimensions of teaching that would be demonstrated by good teachers. *Teaching practice* was one of those dimensions identified. Earlier case studies (Tobin & Fraser, 1988; Treagust, 1991, cited in Waldrip & Fraser), had reached the conclusion that the teaching practice that was particularly noticeable in exemplary teachers was their favourable interaction with students. Building on this, the 2003 study focussed on exemplary science teachers in terms of their teacher-student interactions. Exemplary teachers were defined as those scoring more than one standard deviation above the mean for the positive QTI scales and more than one standard deviation below the mean for the negative scales. The sample of 493 secondary science students from 25 classes completed the questionnaire with the data giving an alpha reliability coefficient of 0.86 for the Helping/Friendly scale. Only Understanding had a higher alpha coefficient (0.87). The process identified five teachers whose students reported interaction scores that were quite different to other teachers. Interviews conducted to verify the statistical results showed that exemplary science teachers were friendly; help a lot; know how to communicate with the students; listen to what the students have to say; and talk to the students. These attributes not only correspond to the questions in the Helping/Friendly scale of the QTI but the Teacher Support scale of the WIHIC as well.

Used in many studies, in many countries, and in relation to different subject areas, the WIHIC had proved itself to be a valid and reliable instrument for examining students' perceptions of their learning environment. Building on the strength of the WIHIC, Aldridge, Fraser, and Fisher (2003) developed the *Technology-Rich Outcomes-Focused Learning Environment Inventory* (TROFLEI) for assessing students' perceptions of their actual and preferred classroom learning environments in technology-rich outcomes-focused learning settings. The instrument comprised the WIHIC scales of Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation, and Equity along with three new scales of Differentiation, Computer Usage, and Young Adult Ethos. There was a total of 76 items across the 10 scales. An 18-item attitude instrument was also developed for the study that encompassed the three scales of Attitude to Subject, Attitude to Computer Use, and Academic Efficacy. The TROFLEI and attitude questionnaires were administered to 1,035 students in a Western Australian senior college where an ICT infrastructure allows delivery of a truly outcomes-focused curriculum, while providing an online curriculum and electronic information management system to teachers and students. Factor analysis confirmed the 10-scale structure while alpha reliability coefficients ranging from 0.91 to 0.94 for the Actual form and from 0.85 to 0.95 for the Preferred form showed a high level of internal consistency. Correlation analysis showed that Teacher Support, and Equity, along with other scales, were significantly and positively related to Attitude to Subject ($p<0.01$) and, further, that Teacher Support, Equity, and Young Adult Ethos uniquely accounted for a significant amount of variance in the students' attitude towards their subject. The paper did not comment on differences between the Actual and Preferred responses.

2.7 Chosen Scales

The learning environment scales focussed on in this research are Teacher Support (the extent to which the teacher helps, befriends, trusts, and is interested in students), and Equity (the extent to which students are treated equally by the teacher). They comprise the items shown in Table 2.2.

The outcome measure of Attitude to Science (the extent to which students are interested in, enjoy, and look forward to science lessons) was assessed by using a seven-item scale adapted from the Test Of Science Related Attitudes (TOSRA). A similar scale, but with eight items, had been used in research previously conducted by Waldrip and Fisher (2002) into Attitude to Science (cited in Dorman et al., 2006). All items used a 4-point response format with Disagree scored 1, and Agree scored 4. Table 2.3 shows the items used in the scale.

Table 2.2.

Items in the Teacher Support, and Equity Scales of the Student Questionnaire

Teacher Support Scale	Equity Scale
The teacher goes out of his/her way to help me.	The teacher gives as much attention to my questions as to other students' questions.
The teacher considers my feelings.	I get the same amount of help from the teacher as do other students.
The teacher talks with me.	I am treated the same as other students in the class.
The teacher is interested in my problems.	I receive the same encouragement from the teacher as other students do.
The teacher moves about the class to talk with me.	I get the same opportunity to contribute to science class discussions as other students.

Table 2.3.

Items in the Attitude to Science Scale of the Student Questionnaire

Attitude to Science Class
I look forward to science lessons.
Science lessons are fun.
I enjoy the activities we do in science.
What we do in science are among the most interesting things we do in class.
Finding out about new things is important.
I enjoy science lessons in this class.
We should spend more time on science each week.

2.8 Summary

Research into learning environments has been happening for many years. Starting with Lewin and Murray in the 1930s, progressing through the work done by Walberg and Moos in the 1960s, taking advantage of the advances in technology with computers and analytical software from the 1960s onwards, and the continual development of data collection instruments ever since, researchers have been able to learn about learners and how they learn in order to advance the delivery of learning.

Acceptance of the use of students' perceptions as a valid means of measuring what was happening in their classroom environment was pivotal to the move from observation data to the formulation of questionnaires as a preferred method of collecting information. It is not only the perceptions of students that have been analysed, of course, but those of all parties involved in the educational process – students, teachers, principals, parents, community members, legislators, and so on. People evaluate any situation according to their own ideas/perceptions and so are well placed to contribute to information about that situation.

Changes in what data were collected about the learning environment and how these data were collected, happened at the same time as changes in how success in that environment is gauged. Passing examinations is no longer the definitive outcome measure of success. In a world where there is more information available than can possibly be taught during the compulsory education years, a positive attitude to learning generally, and a willingness to indulge in life-long learning can also be viewed as measures of success. The information explosion has been largely due to scientific and technological developments and inventions. The future growth and development of society will depend on the availability of people with knowledge of the scientific process and an inquiring mind. Murcia (2005) said that:

> In contemporary times it seems increasingly important to achieve scientific literacy as an educational outcome. It may now even stand along side language literacy and numeracy as an essential tool for living in the 21^{st} century. (p. 2)

The concern is that students' attitude to science is declining at a serious rate (Goodrum et al., 2001) and that there is no strategy in place to address that decline. Development of a relevant and interesting curriculum will take time, and any resultant change in students' attitude to science will not be noticed in the immediate future. This is compounded by the fact that science teaching, in Australia, does not happen in a consistent way at the primary level and so strategies to bring about an attitudinal change now need to be directed at the junior high school level to prompt a flow-on effect into the post-compulsory education years. The change that teachers can make while waiting for policy-based curriculum changes to be implemented is to the learning environment. Halsall (1998), cited in Cavanagh & Waugh (2004), believed that changes to the learning culture require teachers to 'develop new beliefs, attitudes … that will lead to change in classroom practice and improved student educational outcomes'.

Many studies have involved the use of the WIHIC to measure students' perceptions of their learning environment. In those studies, the Teacher Support scale has consistently been related to attitude to the subject. The more highly the students perceive the level of teacher support to be, the more positive their attitude to the subject. Studies have also shown that equitable treatment in the classroom significantly and positively contributes to attitude. Past research, however, has not focussed on teacher support and equitable treatment and their impact on attitude to science even though they are defined as major aspects of the role of being a teacher.

The similar scale of Helping/Friendly in the QTI has shown the same result. Whilst such studies have shown significant interaction effects between the different scales of the instrument, it has been the Helping/Friendly scale that has consistently been related to attitude to the particular subject area. The more highly the students perceives the teacher to behave in a helping/friendly way, the more positive their attitude to the subject.

Previous research has examined the learning environment and student–teacher interactions at the primary school level, high school level, and at university. Whilst the results have been important in the understanding of the perceptions of students, revealing the findings has not arrested the declining interest in science. An Australian government report (Goodrum et al., 2001) has found that science education in primary schools is not approached in a consistent manner making it difficult at the present time to evaluate and introduce relevant measures to address the decline at that stage. The middle schooling years of Grades 8, 9 and 10 are when science becomes a core subject area. It is also the time when students become more independent and formulate attitudes and opinions that will shape their post-compulsory education years.

This current research, then, is unique in that it combines all these aspects. Using quantitative data collected from these important school years, it investigates the students' perceptions of the key teaching role behaviours of support and equitable treatment and the impact they have on attitude to science. Qualitative data collected from a small sample of teachers provides contextual information for the findings, allowing the opportunity to discuss the research from both perspectives and suggest strategies that could have immediate impact on the future of science learning in Australia.

CHAPTER THREE

RESEARCH METHOD

3.1 Introduction

The 1960s was a defining decade for research, and educational research in particular. It was the time when large-scale computers moved from a predominantly government application to university environments bringing with them the capacity to process large amount of data in a relatively short time. It was the time when Walberg first demonstrated the appropriate use of a questionnaire to collect student data on learning environments. It was also the time when the software data analysis package SPSS was first written.

In the decades since then computers, questionnaire use, and statistical software have developed substantially to bring research to today’s level. Technology has increased the power and potential of computers but drastically reduced their physical size. Questionnaires are now used as the major source of data collection with word processing making them easier to create in the first place. They increase the volume of data that can be collected while reducing the amount of time taken to do so. SPSS has moved from a technical, syntax based package to a menu driven Windows package making it much easier for researchers to use its increased statistical power while substantially reducing the lead-in learning time.

The advantages of the increased automation described above also have the potential to bring with them detachment from the data on the part of the researcher. Whilst it may not be desirable to return solely to the days of collecting information by observation (Dorman, 2002), gathering supplementary information by observation or interview may help the researcher explain or understand the nature of the findings. In a paper describing the use of quantitative and qualitative methodologies, Tobin and Fraser (1998) concluded that ‘… we advocate the use of both in an effort to obtain credible and authentic outcomes’ (p. 639).

The present study has taken advantage of the potential offered by computers, questionnaires, and data analysis software for recording student perceptions but has also included interviews with four teachers to help the researcher gain insight into an the environment of the science classroom.

The purpose of the study was to examine the contribution that teacher support and equitable treatment in the classroom made to the students' attitude towards science. With a declining interest in science being manifested in declining numbers of students taking science subjects, but with the increased need for scientific knowledge in graduates and the community generally, it is important to identify any change in teacher practice that might halt that decline. Improved teacher – student interactions, of which support and equity are two, could improve the general attitude to science thus promoting an ongoing interest in the subject. Given that, as yet, science is not necessarily taught in primary schools, developing an improved attitude and increased interest in the lower high school years is the first step in the process. This study surveyed students in years 8, 9 and 10 in Australian science classes.

The student questionnaire used to collect the quantitative data, specifically the teacher support, equity and attitude items pivotal to this study, is discussed in Section 3.2 of this chapter. Whilst the main focus of the study was the quantitative data, supplementary information was also gathered by interviewing three teachers and one pre-service teacher. This process is described in Section 3.3. The methods used to collect the quantitative and qualitative data are described in sections 3.4 and 3.5, respectively. The data analysis processes in relation to each of the research questions posed for the student data are set out in Section 3.6. The approach taken with the interview data is given in Section 3.7 whilst the privacy, confidentiality, and ethical matters are detailed in Section 3.8. A summary of all the information in this chapter is given in Section 3.9.

3.2 Students' Questionnaire

The questionnaire used in this research was originally developed for a larger study which focussed on improving assessment in science through the use of students' perceptions of their assessment in science, their learning environment, and their attitude to science generally. The Australian Research Council (ARC) funded the study, and the Chief Investigators were Professor Darrell Fisher, from the Science and Mathematics Education Centre at Curtin University of Technology, Associate Professor Bruce Waldrip, from the Faculty of Education at the University of Southern Queensland, and Associate Professor Jeffrey Dorman, from the School of Education at the Australian Catholic University.

The instrument comprised four sections:

1. Demographic information
2. The Students' Perception of Assessment Questionnaire (SPAQ)
3. Learning environment scales
4. Student attitude to science scales

A copy of the instrument is given in Appendix A.

3.2.1 Demographic Information

The demographic information collected from the students was the name of their school, their year level and their gender. The names of the schools were coded numerically before being entered into the data file but were not used for this particular study. At the time of data entry, a code was also created for the state in which the school was situated in (Australian Capital Territory, Queensland, and Western Australia). This was not required for data analysis purposes but served as a tracking mechanism for the data entry. A breakdown of the initial number of respondents in each state is given in Table 3.1.

The junior high school years cover such a range of educational experience that it was important to consider year level when examining the students' perceptions of support, equity and attitude. The Year 8 students, fresh from primary school, are likely to carry with them expectations of the nurturing, mothering, style of teaching experienced previously. This could affect their perception of the teacher – student relationship experienced in the high school classroom. Year 9 students will have adjusted to the different teaching style of the high school environment but may still be immature in their concepts and so have their own level of perception. Year 10 students will be more aware of their skills and abilities and be more definite in their likes and dislikes. Their level of perception will be different again. A breakdown of the initial number of respondents at each year level is given in Table 3.1.

Of all school subjects, probably the greatest differences between the genders occurs in science (Baker, 1997; Parker, Rennie, & Fraser, 1996). To determine whether the gender of the students affected their perceptions of teacher support, equity and attitude, respondents were asked to record this information also. A breakdown of the initial number of males and females is given in Table 3.1.

Table 3.1

Initial Frequency Distributions of the Demographic Information from the Student Questionnaire

State		Year level		Gender	
ACT	614	Years 5 to 7	342	Female	1,029
Queensland	950	Year 8	742	Male	1,175
WA	642	Year 9	680	No answer	2
		Year 10	436		
Total	2,206		2,206		2,206

3.2.2 Students' Perception of Assessment Questionnaire (SPAQ)

This section of the instrument comprised 30 items divided into five scales measuring Congruence with Planned Learning, Authenticity, Student Consultation, Transparency, and Diversity. There were five items in each scale and each item was measured on a 4-point system from 'Almost Never', coded 1, to 'Almost Always', coded 4. Whilst the items were grouped together according to the scales, the scale itself was not identified on the questionnaire.

Validity and reliability for the SPAQ was established by the investigators for the ARC study and have been reported along with other findings in Dorman, Fisher, and Waldrip (2006).

3.2.3 Learning Environment

The learning environment section of the instrument comprised 25 items each measured on a 4-point scale from ‘Almost Never’, coded 1, to ‘Almost ‘Always’, coded 4. These 25 items formed five scales measuring Student Cohesiveness, Teacher Support, Involvement, Task Orientation, and Equity in the classroom. There were five items in each scale. Whilst the questions were grouped together according to the scale, the scale itself was not identified on the questionnaire.

The validity and reliability of the WIHIC questionnaire from which the scales were derived for the learning environment section of the current instrument have been established in other studies (see Section 2.2 earlier). The validity under the current structure is reported in terms of factor structure and reliability in Chapter 4.

The two scales that the present research focuses on are Teacher Support and Equity. Teacher Support measures the extent to which the science teacher helps students and takes a personal interest in them (e.g., “The teacher goes out of his/her way to help me.”). Equity measures the extent to which the science teacher treats all students the same way (e.g., “I get the same amount of help from the teacher as do other students.”)

3.2.4 Attitude to Science

The attitude section of the questionnaire comprised 14 items, each one measured on a 4-point scale from ‘Disagree’, coded 1, to ‘Agree’ coded 4. These 14 items made up the two scales of Attitude to Science, and Self-efficacy. There were seven items in each scale and the scales were not identified as such on the instrument.

The Attitude to Science scale used in this research comprises responses to such statements as “I look forward to science lessons” and “Science lessons are fun”.

The validity and reliability of the TOSRA questionnaire, from which the Attitude section of the current instrument was derived, have been established in previous studies (see Section 2.6) and most recently in Dorman, Fisher, and Waldrip (2006).

The validity under the current structure is reported in terms of factor structure and reliability in Chapter 4.

3.3 Interviews with Teachers

Whilst the emphasis in this research had been the analysis of quantitative data collected from students, it was considered appropriate and perhaps necessary to gather additional background information from some teachers. This information was to assist in the understanding of what was required to be a teacher of science from the teachers' perspective and to establish if there was a difference in how teachers perceive the students' attitude to science to that determined by the students themselves.

The four interviews were conducted separately and informally. The questions covered seven broad areas:

- The interviewee's own science education
- Science education in their current teaching situation
- The science teaching that they do
- Their perceptions of students' attitude to science
- The ideal science class environment from a teaching perspective
- The ideal science class environment from a learning perspective
- Science teaching and/or learning in general

The main and associated secondary questions, along with the responses are given in Chapter 5.

3.4 Quantitative Data Collection

The states chosen to provide the quantitative data were known to be representative of the diversity of learning situations throughout Australia and also because of their familiarity to the Chief Investigators of the ARC study.

The questionnaires were completed by the students during class time and then collected for entry into a database in each state. The three files were then amalgamated into the one file for analysis using the SPSS software package.

3.5 Qualitative Data Collection

The four people interviewed were chosen because they were known to this researcher and represented a variety of teaching environments, namely a non-government primary school, a government high school, an alternative middle schooling college, and a pre-service primary teacher planning to go into the government system. All were from Western Australia.

The interviews were conducted separately, in an informal atmosphere, and at a time and place convenient to both parties. The interviewees were given a copy of the schedule at the time of interview and were invited to provide any further information or thoughts via email at a later date. Their responses were not subjected to a formal qualitative analysis with respect to the research questions but were used to give background information from the teachers' perspective.

3.6 Analysis of the Quantitative Data

The analysis of the quantitative data was completed using the software package SPSS version 14. The syntax file containing the commands used during the analysis is given in Appendix C.

The first data file that was created by amalgamating the files from the three surveyed states was checked for data entry errors by producing frequency distributions for each question/variable. A number of anomalies were identified by this process and corrections made. A decision was made to remove the cases that were not from year 8, 9 or 10 students and also to remove those cases that had incomplete data. This process reduced the data file down to 1,775 cases. The frequency distributions were re-run along with means and standard deviations to provide descriptive information for tabulation.

Principal component analysis was used to confirm the factor structure of the 30-item assessment section, the 25-item learning environment section, and the 14-item attitude section. Each scale identified was then tested for internal consistency by use of the Cronbach Alpha coefficient through the Reliability procedure.

Once the reliability had been established, a latent variable was created for each scale within the learning environment and attitude sections of the questionnaire. To do this, the mean score of the items within each scale was computed. Means were calculated so that the resultant variable was scored in a comparable way to the original items, that is, in a range from 1 to 4. Since all the items were worded positively, and the response codes increased as the response became more positive, the higher scores could be interpreted as a more favourable perception by the respondents. A new variable was also created which reflected the combination of gender and year group categories, for example, Year 8 female, Year 8 male, Year 9 female.

Before addressing the research questions, analysis was done on each scale variable, namely Teacher Support, Equity, and Attitude, to test for normality. This was done using the Explore procedure with the Kolmogorov-Smirnov Test of Normality. This test is used for samples over 50 cases and tests the null hypothesis that there is no difference between the distribution being tested and a normal distribution. The Explore procedure also gave Normal Q-Q plots allowing a visual check of the distribution against the normal distribution line. Establishing normality, or otherwise, is necessary to determine whether parametric or non-parametric statistical tests should be used. The large sample size of 1,775 cases, however, meant that parametric statistical tests would be appropriate. To ensure that this was the case, parametric and non-parametric statistical tests were used in all instances. The results were compared to ensure they were consistent. Since there were no differences in the significance of the results, the parametric ones were used as they relate more closely to the original data. The information provided by the parametric procedures allows discussion of means and standard deviations; whilst the non-parametric procedures provide information in terms of mean ranking which does not relate directly to how the original variables were coded.

As part of the exploratory process for each scale, gender differences where examined using an Independent Samples *t* test and the non-parametric Mann-Whitney test; year group differences where examined using an Analysis of Variance (Oneway) and the non-parametric Kruskal-Wallis test; and differences across gender and year group combinations were tested also using an Analysis of Variance (Oneway) and the non-parametric Kruskal-Wallis test.

The Independent Samples *t* test allows the null hypothesis that there is, statistically, no significant difference between the mean scores (Teacher Support, for example) of two independent groups (e.g., male and female) to be addressed. It has the underlying statistical assumptions that the dependent variable is measured at least at the interval level, and is normally distributed. It also assumes that the variances in the two groups are roughly equal, that is, there is homogeneity of variance. The Levene's test for equality of variance is built into the Independent Samples *t* test in SPSS thus allowing both homogeneity of variance and comparison of the means to be performed in the one operation.

The non-parametric Mann-Whitney test also compares two groups (males and females, for example) but has no underlying statistical assumptions other than the two groups are independent of each other. In this test the values of a dependent variable, such as Teacher Support, are sorted into ascending order and assigned a ranking number so that the lowest value is given a rank of 1, the next lowest value is given a rank of 2, and so on. This means that low scores are given low ranks and high scores are given high ranks (Field, 2005). The analysis then reports and compares mean rankings for the groups rather than actual mean scores for the groups.

When comparing more than two groups, such as the three school years in this study, the parametric Analysis of Variance (ANOVA) or non-parametric Kruskal-Wallis tests were required. For the purposes of this study, the SPSS Oneway procedure was used since this performs the equivalent of an ANOVA but has the provision for only one dependent and one independent variable to be used and that was all that was required initially.

The Oneway procedure allows the null hypothesis that there is, statistically, no significant difference between the mean scores (Teacher Support, for example) of three or more independent groups (e.g., Year 8, Year 9 and Year 10) to be addressed. It has the underlying statistical assumptions of homogeneity of variance, normally distributed data, independent groups, and a dependent variable that is measured on at least an interval scale. The results from the procedure focus on the mean scores and thus relate directly to the original coding scheme of the dependent variable. In order to do multiple comparisons of the groups, the Scheffe post hoc test was used from within Oneway. The Scheffe test performs simultaneous joint pairwise comparisons for all possible pairs of combinations of means and reports whether there is a statistically significant difference for each pair. It assumes homogeneity of variance.

The non-parametric Kruskal-Wallis test has no underlying statistical assumptions other than that the three or more groups are independent of each other. It relies on ranked data and thus reports the results in that way.

Each of the scales was also analysed using Oneway ANOVA with the created variable giving the gender and year group combinations as the independent variable. Scheffe post hoc tests were included to look for pairwise differences between the combinations.

To complete the exploratory part of the analysis, univariate ANOVA was used to check for any interaction effect that the independent variables of gender and year group might have on each of the Teacher Support, Equity, and Attitude scales. Univariate ANOVA has the same statistical assumptions as Oneway ANOVA, namely, homogeneity of variance, normally distributed data, independent groups, and a dependent variable that is measured on at least an interval scale.

Once these initial analyses had been completed the research questions were then addressed.

Research questions 1 and 2 look at whether students' perceptions of teacher support and equity, respectively, affect their attitude to science classes. Whilst the analysis for each question was done separately, the same statistical technique was used.

Initially, both parametric and non-parametric correlations were done with the three scale variables. This was followed by a simple regression analysis with Attitude as the outcome variable and each of Teacher Support and Equity as the independent or predictor variables.

Correlation is a measure of the linear relationship between pairs of variables and was used to check for any collinearity. Regression tests how much one independent or predictor variable affects the outcome variable.

Research question 3 asked whether the perceptions of teacher support combine with those of equity to affect attitude to science. To address this, multiple regression was used with Teacher Support and Equity both specified as the predictor variables and Attitude as the outcome variable. The statistical assumptions underlying regression analysis are that the variables are all measured on at least an interval scale, that there is no perfect collinearity, and that there is a large enough sample size.

Research question 4 looked at whether the teacher support – equity – attitude relationship was different between the genders. To do this, the multiple regression used for research question 3 was repeated but separately for each of males and females. Similarly for research question 5, the regression was used separately for each of Years 8, 9, and 10 to see if there were any differences.

3.7 Analysis of the Qualitative Data

The information collected via interviews with the teachers was not formally analysed via text analysis software. The answers provided by the pre-service teacher and three current teachers were collated manually and reviewed to establish perceptions of teaching and learning science from the adult perspective.

Part of the information was used to address research question 6, which is to ascertain the teachers' perception of the science learning environment, including how the teachers' perceive the students' attitude to science. This could only be achieved at a superficial level in this study since the convenience sample of four teachers could not be presumed to be representative of all teachers.

3.8 Privacy, Confidentiality and Ethical Considerations

The ARC study was explained to the parents in a letter and written permission was sought for the child to participate thus providing the quantitative data. Participation was voluntary and could be withdrawn at any time. The parent letter is given in Appendix B. The questionnaire was administered in class time in the chosen schools, permission having been previously obtained from the school principals and class teachers.

Privacy and confidentiality was maintained during the collection of the data since students were not required to identify themselves on the questionnaires. For data entry purposes only, each questionnaire was numbered sequentially after they had been completed and handed-in. The numbers allocated were not recorded against names of students guaranteeing anonymity.

The state, school, and class information was numerically coded and recorded in the electronic data file for tracking and data cleaning purposes only. The information was not used for comparative purposes in this current research. Year level was also recorded, as this was fundamental to the data analysis. All results have been presented in a summarised year level form preventing identification of individual, state, school, or class.

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 has also been burned to a CD for separate storage by this researcher. The questionnaires have been placed in secure storage with the principal ARC researchers in each state and will be destroyed five years after completion of the study.

Whilst the names of the four people interviewed are known to the researcher, they have not been included as part of the reporting process. The teachers interviewed are identified as PT1, ST1, and ST2 while the pre-service teacher is identified as PST1. This was explained to the four subjects at the time of interview.

The four teachers who were interviewed were contacted directly and the reasons given verbally behind being asked to participate. It was explained that neither they nor their schools would be identified by name and that they could withdraw at any time. Permission was obtained to electronically record the complete interviews. No written notes were taken. Responses to questions were then transcribed in an abbreviated form for inclusion in this thesis. This process was also explained to the teachers prior to starting the interviews. The recordings do not include the name of the participant electronically but their first name was written on the casing for each tape. These are also in secure storage and will be destroyed at the end of five years.

3.9 Summary

The purpose of this study was to investigate students' perceptions of teacher support and equity in the classroom and their impact on students' attitudes towards science.

The instrument used to gather the students' responses had four sections comprising demographic information, the Students' Perceptions of Assessment Questionnaire, 25 items relating to perceptions of the learning environment, and finally 14 items relating to students' attitude. The items in the learning environment section made up five scales – Teacher Support, Equity, Task Orientation, Student Cohesiveness, and Involvement. The student attitude items formed two scales – Attitude to Science, and Self-efficacy.

Data were collected from students in the ACT, Queensland, and Western Australia. Initially there were 2,206 respondents but this was reduced to 1,775 as a result of removing cases with incomplete data and those who did not fit into the requirements for this study.

The data were analysed by means of the software package SPSS version 14 using descriptive statistics, analysis of variance, correlations, and simple and multiple regression.

Supplementary information was provided through interviews conducted with a pre-service primary school teacher, a current primary school teacher, a science teacher in a government high school, and a science teacher in an alternative style middle college. This qualitative data were not subject to formal data analysis but used to give a different perspective on the issue of declining interest in science subjects by current students.

CHAPTER FOUR

QUANTITATIVE RESULTS

4.1 Introduction

This chapter gives the results of the analyses of the quantitative data. Section 4.2 details the characteristics of the respondents. Sections 4.3 to 4.5 deal with the scales of Teacher Support, Equity in the classroom, and Attitude to Science Class, respectively, looking at gender differences, comparing year groups, testing gender and year group interactions, and then examining gender and year group combinations. Section 4.6 examines the relationships between the scales including whether Teacher Support and Equity are predictors of Attitude. Section 4.7 looks at the effect of gender on the Support – Equity – Attitude relationship while Section 4.8 explores the effect of year groups. Finally this chapter gives a brief overview of the other learning environment scales used in the questionnaire, namely Student Cohesiveness, Involvement, and Task Orientation with gender and year group comparisons. However, the information is given for completeness and does not form part of this study.

4.2 Participant Characteristics

Approximately 2,500 questionnaires were distributed to schools in the Australian Capital Territory (ACT), Queensland (Qld), and Western Australia (WA). Of these, 2,206 were returned. Frequency distributions of the data showed that some students in years other than 8, 9, and 10 had completed the questionnaires and they were removed from the dataset leaving 1,854 cases. Further examination of the data showed that 89 (4.78%) respondents had not answered all of the questions and so they were also removed, leaving the final total of 1,775 cases. Table 4.1 shows the distribution of those cases by state, year group and gender.

Table 4.1

Descriptive Statistics of Participants by State

		Female		Male		Total
		N	%	N	%	N
ACT	Year 8	76	(44.2)	96	(55.8)	172
	Year 9	123	(51.7)	115	(48.3)	238
	Year 10	65	(54.2)	55	(45.8)	120
	Total	264	(49.8)	266	(50.2)	530
Queensland	Year 8	156	(53.6)	135	(46.4)	291
	Year 9	106	(53.5)	92	(46.5)	198
	Year 10	59	(49.2)	61	(50.8)	120
	Total	321	(52.7)	288	(47.3)	609
WA	Year 8	67	(27.9)	173	(72.1)	240
	Year 9	76	(36.4)	133	(63.6)	209
	Year 10	85	(45.5)	102	(54.5)	187
	Total	228	(35.8)	408	(64.2)	636

The structure of the learning environment section of the questionnaire was checked using a Principal Components Factor Analysis (PCA) with Kaiser Normalisation and Varimax Rotation. Factor loadings less than 0.40 were excluded. The results are given in Table 4.2. They confirm the five discrete scales of Teacher Support, Equity, Task Orientation, Student Cohesiveness, and Involvement as designed.

The structure of the attitude section of the questionnaire was also checked using a Principal Components Factor Analysis (PCA) with Kaiser Normalisation and Varimax Rotation. Factor loadings less than 0.40 were excluded. The results are given in Table 4.3. Whilst item 5 (“Finding out about new things is important”) and item 8 (“ I feel pleased with myself with what I learn in science”) loaded above 0.4 on both factors, the Cronbach Alpha coefficient indicated that the internal consistency was high for both scales irrespective of where those items were included. Since the original design of the survey had item 5 in the Attitude scale and item 8 in the Efficacy scale that is where they were placed for the purpose of ongoing analysis.

Table 4.2

Learning Environment Confirmatory Factor Analysis Results

Item	Teacher support	Equity	Task orientation	Student cohesiveness	Involvement
9	.79				
7	.78				
8	.76				
6	.73				
10	.73				
23		.77			
24		.76			
22		.74			
25		.74			
21		.71			
18			.74		
16			.74		
19			.73		
17			.71		
20			.65		
3				.81	
1				.76	
4				.72	
5				.71	
2				.67	
12					.83
11					.76
13					.74
15					.64
14					.50
Eigenvalue	9.18	2.36	1.75	1.64	1.17
Cummulative %	36.71	46.14	53.15	59.71	64.45
% Variance	36.71	9.44	7.00	6.56	4.74

N = 1,775

Table 4.3

Student Attitude Confirmatory Factor Analysis Results

Item	Attitude	Efficacy
2	.85	
6	.83	
1	.82	
4	.78	
3	.77	
7	.72	
8	.51	.50
5	.42	.52
13		.81
12		.80
10		.79
14		.79
11		.77
9		.71
Eigenvalue	7.19	1.89
Cummulative	51.33	64.80
% Variance	51.33	13.46

N = 1,775

4.3 Teacher Support Scale

The Teacher Support scale was made up of five items within the Learning Environment set of questions. Each question was answered on a 4-point scale from Almost Never, scored 1, to Almost Always, scored 4. Table 4.4 shows the distributions of responses to each item and the mean score and standard deviation for each one.

Table 4.4

Descriptive Statistics of the Teacher Support Scale

Item	Almost never %	Some-times %	Often %	Almost always %	Mean	SD
The teacher goes out of his / her way to help me	17.8	32.1	29.3	20.8	2.53	1.01
The teacher considers my feelings	21.2	32.0	25.9	20.8	2.46	1.04
The teacher talks with me	13.6	32.3	27.8	26.3	2.67	1.01
The teacher is interested in my problems	26.0	32.1	24.6	17.3	2.33	1.04
The teacher moves about the class to talk with me	20.2	32.1	27.3	20.4	2.48	1.03

N = 1,775

The Cronbach Alpha coefficient of 0.89 (N = 1,775) showed that the scale has a high internal consistency. This, coupled with the strong results from the factor analysis, determined that it was appropriate to create the Teacher Support scale from the five items. Calculating the mean so that the resultant variable was scored in a comparable way to the original items did this. Table 4.5 shows the Teacher Support scale broken down by year group and gender.

The Kolmogorov-Smirnov Test of Normality showed that the Teacher Support scale was significantly different ($p<0.001$) to a normal distribution for the overall variable and for each of the genders and school years. Figure 4.1 shows the boxplots for the scale for each group. The plots show that the difference to the normal distribution is not visibly substantial so both parametric and non-parametric tests were conducted to check for consistency of results. Since there was no difference, only the parametric results are given.

Table 4.5

Mean of the Teacher Support Scale broken down by Year Group and Gender

School year	Gender	N	Mean	Standard Deviation
Year 8	Female	299	2.74	.84
	Male	404	2.65	.79
	Total	703	2.69	.82
Year 9	Female	305	2.32	.86
	Male	340	2.32	.86
	Total	645	2.32	.86
Year 10	Female	209	2.50	.88
	Male	218	2.38	.83
	Total	427	2.44	.85
Total	Female	813	2.52	.88
	Male	962	2.47	.84
	Total	1,775	2.49	.86

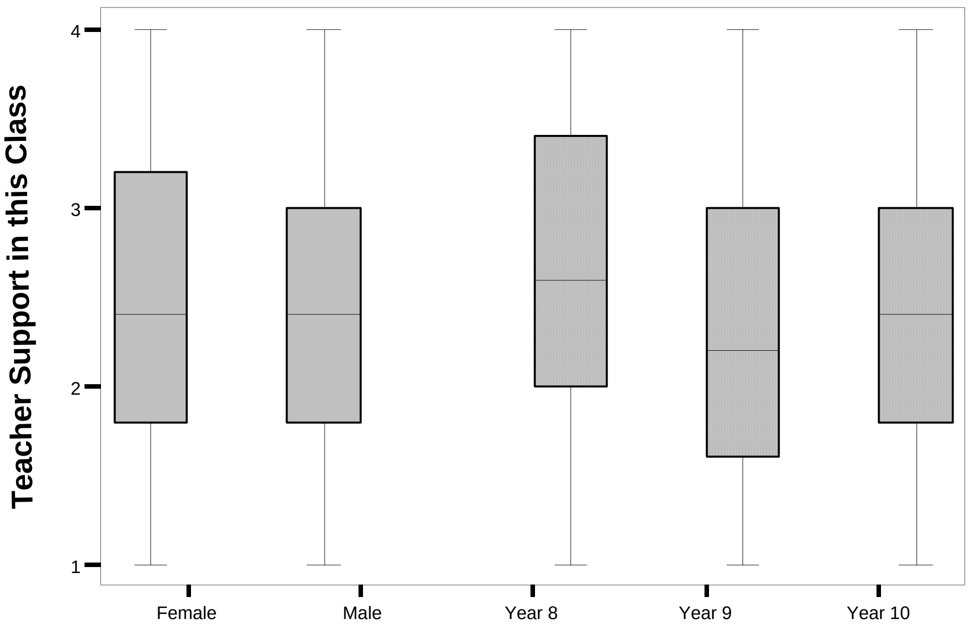

Figure 4.1. Boxplots of the Teacher Support scale for gender and year group.

Table 4.5 reports that the score for Teacher Support for the females (Mean = 2.52, SD = 0.88) was higher than for the males (Mean = 2.47, SD = 0.84). Since the original items were scored from 1 to 4, with 4 representing the desirable response of Almost Always, this suggests that females perceive Teacher Support in the science classroom to be higher than the males do. The independent samples t test, however, showed the difference not to be statistically significant (t (1773) = 1.298, $p > 0.05$).

To compare Teacher Support across the three year groups a one-way Analysis of Variance was used. There was a statistically significant difference across the groups (f (2,1772) = 33.88, $p < 0.001$). Further post hoc tests (Scheffe) showed that there was a statistically significant difference in the mean score for the Year 8 students to those of both Year 9 and Year 10 ($p < 0.001$). Years 9 and 10 were not significantly different to each other ($p > 0.05$). The Year 8 students had a higher mean score indicating that they perceive the Teacher Support in the science classroom to be higher than do the other two year groups. The Year 9 students gave the lowest rating (see Table 4.5).

A univariate Analysis of Variance was used to test for any interaction effect between gender and year group in regard to teacher support. The results showed that there was a significant main effect of year group (f (2,1769) = 34.70, $p < 0.001$) but a non-significant main effect of gender (f (1,1769) = 3.33 , $p > 0.05$). The interaction effect between gender and year group on the perceived level of teacher support was also non-significant (f (2,1769) = 0.80, $p > 0.05$). The results are represented graphically in Figure 4.2.

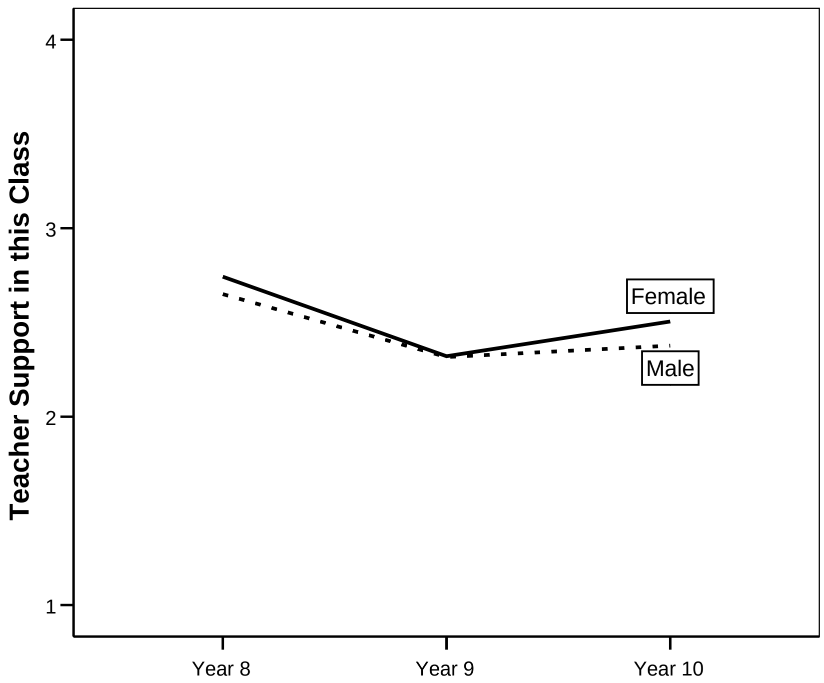

Figure 4.2. Line graph of the interaction of gender and year group on teacher support.

To check for any differences in perceived Teacher Support between school year and gender combinations, a new variable was created with the required six categories.

A one-way Analysis of Variance using the derived groups showed that there was a statistically significant difference in the perceived Teacher Support scores (f (5, 1769) = 14.47, $p < 0.001$). The Scheffe post hoc test indicated that whilst the Year 8 females were not significantly different to the Year 8 males, both groups were significantly different to all other groups except Year 10 females ($p < 0.001$).

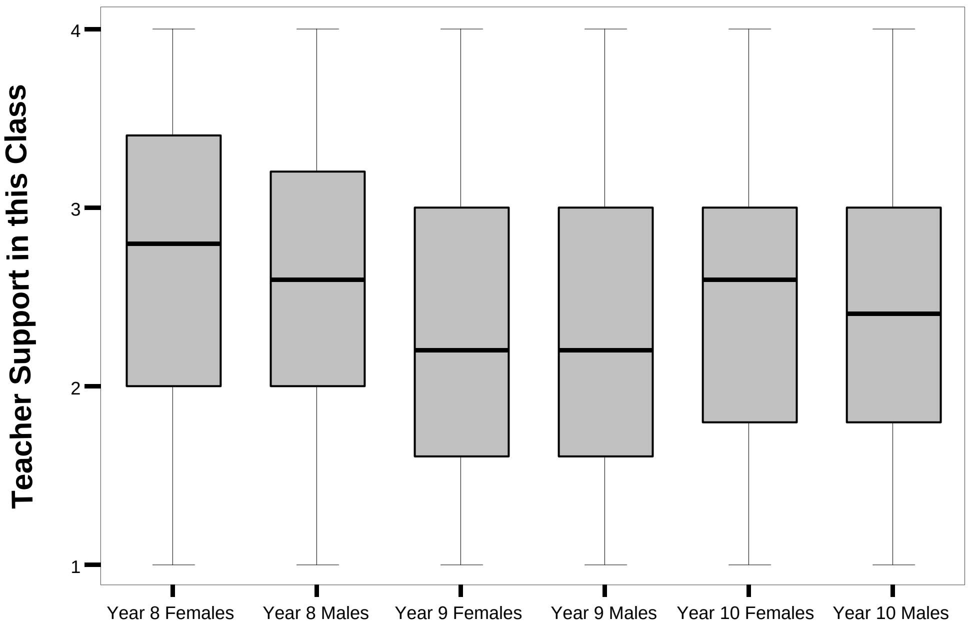

Figure 4.3. Boxplots of the Teacher Support scale for year group and gender combinations.

The mean Teacher Support scores for the Year 8 females (Mean = 2.74, SD = 0.84), for the Year 8 males (Mean = 2.65, SD = 0.79) and for the Year 10 females (Mean = 2.50, SD = 0.88) were higher than all the other groups suggesting they perceived a higher level of Teacher Support in the classroom.

4.4 Equity Scale

The Equity scale was made up of five items within the learning environment set of questions. Each item was answered on a 4-point scale from Almost Never, scored 1, to Almost Always, scored 4. Table 4.6 shows the distributions of responses to each item and the mean score and standard deviation for each one.

Table 4.6

Descriptive Statistics of the Equity Scale

Item	Almost never %	Some-times %	Often %	Almost always %	Mean	SD
The teacher gives as much attention to my questions as to other students' questions	12.5	22.8	29.0	35.8	2.88	1.04
I get the same amount of help from the teacher as do other students	10.6	24.3	30.0	35.1	2.90	1.00
I am treated the same as other students in the class	8.1	19.6	29.1	43.2	3.07	.97
I receive the same encouragement from the teacher as do other students	8.6	21.8	29.2	40.4	3.01	.98
I get the same opportunity to contribute to class discussions as other students	7.5	19.9	30.8	41.7	3.07	.96

N = 1,775

The Cronbach Alpha coefficient of 0.89 (N = 1,775) showed that the scale had a high internal consistency. This, coupled with the strong results from the factor analysis, determined that it was appropriate to create the Equity scale from the five items. This was done by taking the mean so that the resultant variable was scored in a comparable way to the original items. Table 4.7 shows the Teacher Support scale broken down by year group and gender.

Table 4.7

Mean of the Equity Scale broken down by Year Group and Gender

School year	Gender	N	Mean	Standard Deviation
Year 8	Female	299	3.17	.74
	Male	404	3.02	.76
	Total	703	3.09	.76
Year 9	Female	305	2.91	.86
	Male	340	2.82	.88
	Total	645	2.86	.87
Year 10	Female	209	3.12	.88
	Male	218	2.91	.83
	Total	427	3.01	.86
Total	Female	813	3.06	.83
	Male	962	2.92	.82
	Total	1,775	2.99	.83

The Kolmogorov-Smirnov Test of Normality showed that the Equity scale was significantly different ($p < 0.001$) to a normal distribution for the overall variable and for each of the genders and school years. Figure 4.4 shows the boxplots for the scale for each group. Whilst the plots show a skew, both parametric and non-parametric tests showed the same results so only the parametric ones are given.

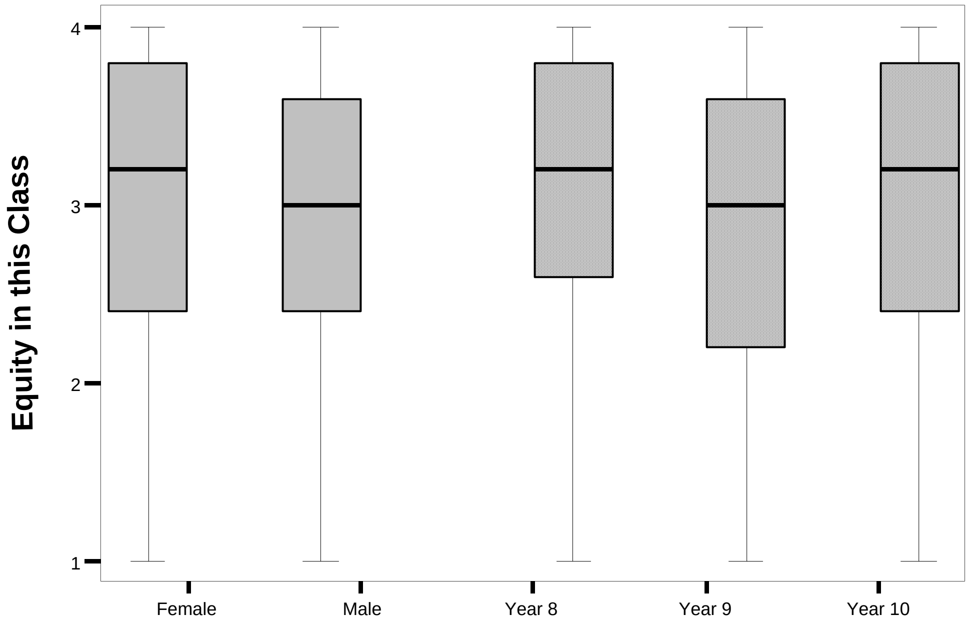

Figure 4.4. Boxplots of the Equity scale for gender and year group.

The mean score for the Equity scale for the females was higher than for the males (see Table 4.7). Since the original items were scored from 1 to 4, with 4 representing the desirable response of Almost Always, this suggests that females perceive equity in the science classroom to be higher than the males do. The Independent Samples *t* test showed the difference to be statistically significant (t (1773) = 3.40, $p < 0.01$).

To compare the Equity scale across the three year groups a one-way Analysis of Variance was used. The results showed that there was a statistically significant difference between the groups (f (2,1772) = 12.84, $p < 0.001$). Further post hoc tests (Scheffe) showed that there was a statistically significant difference in the mean score for the Year 9 students to those of both Year 8 and Year 10 ($p < 0.05$). Years 8 and 10 were not significantly different to each other ($p > 0.05$). The Year 9 students had a lower mean score indicating that they perceive the equity in the science classroom to be lower than the other two year groups. The Year 8 students gave the highest rating (see Table 4.7).

A univariate Analysis of Variance used to test for any interaction effect between gender and year group in regard to equity showed that there was a significant main effect of year group (f (2,1769) = 13.75, $p < 0.001$) and of gender (f (1,1769) = 13.79,

$p < 0.001$). However, the interaction effect between gender and year group on the perceived level of equity was non-significant (f (2,1769) = 0.75, $p > 0.05$). The results are represented graphically in Figure 4.5.

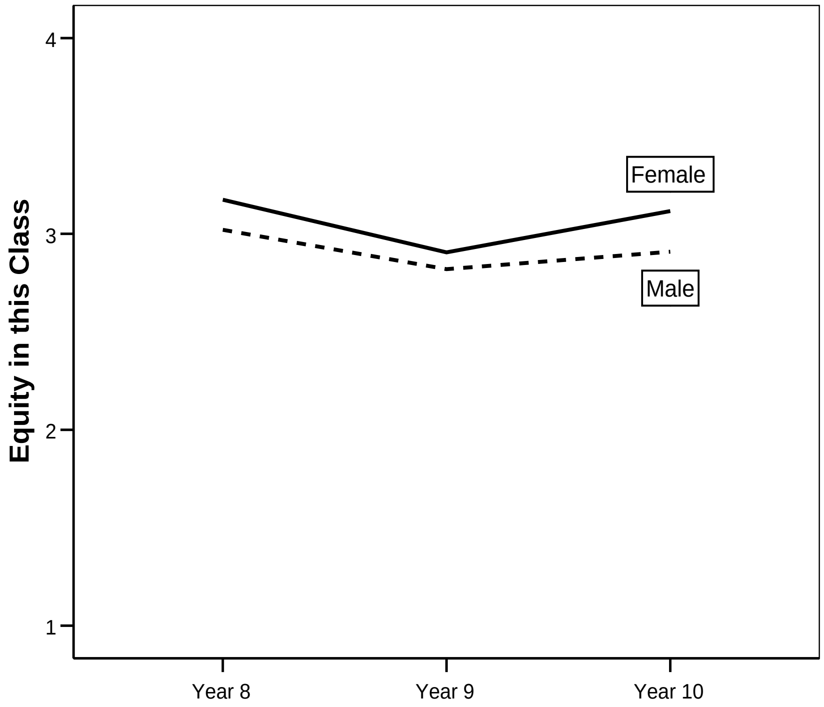

Figure 4.5. Line graph of the interaction of gender and year group on equity.

To check for any differences in perceived Equity between school year and gender combinations, the derived variable was used in a one-way Analysis of Variance. The results showed that there was a statistically significant difference in the perceived Equity scores (f (5,1769) = 8.08, $p < 0.001$). The Scheffe post hoc test indicated that the Year 8 females were significantly different to all groups except Year 8 males and Year 10 females ($p < 0.01$). Year 10 females were also significantly different to the Year 9 males ($p < 0.01$).

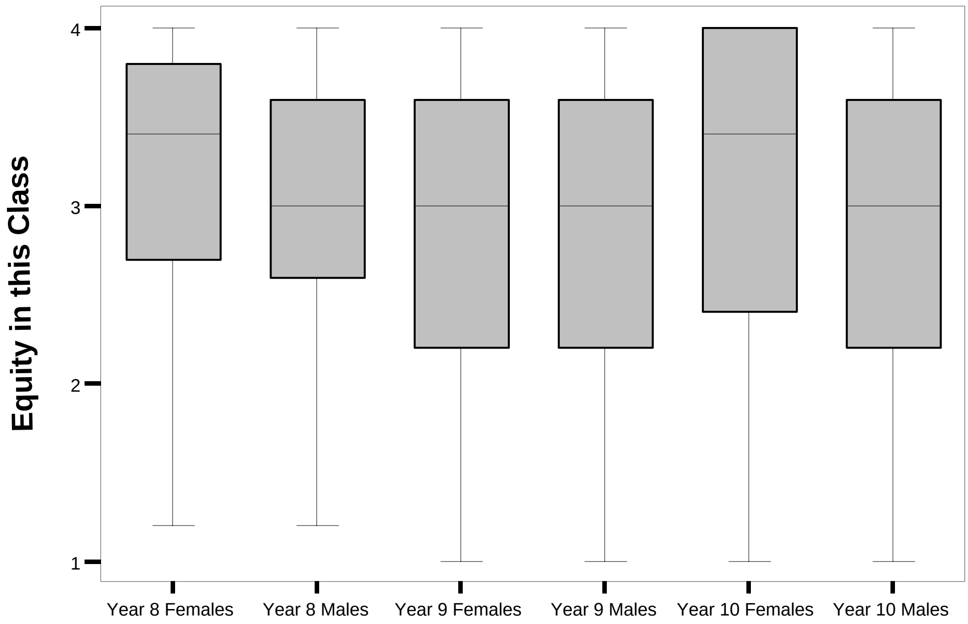

Figure 4.6. Boxplots of the Equity scale for year group and gender combinations.

The mean Equity score for the Year 8 females (Mean = 3.18, SD = 0.74) and for the Year 10 females (Mean = 3.12, SD = 0.88) were higher than all the other groups suggesting they perceived a higher level of equitable treatment in the classroom.

4.5 Attitude to Science Class

The Attitude scale was made up of seven questions within the Student Attitude section of the survey. Each question was answered on a 4-point scale from Disagree, scored 1, to Agree, scored 4. Table 4.8 shows the distributions of responses to each item and the mean score and standard deviation for each one.

Table 4.8

Descriptive Statistics of the Attitude to Science Class Scale

	Disagree	2	3	Agree		
Item	%	%	%	%	Mean	SD
I look forward to science lessons	24.4	26.7	34.2	14.7	2.39	1.01
Science lessons are fun	21.6	31.3	33.9	13.2	2.39	.97
I enjoy the activities we do in science	15.0	28.7	37.2	19.0	2.60	.96
What we do in science are among the most interesting things we do in class	24.7	31.7	31.2	12.3	2.31	.98
Finding out about new things is important	8.0	16.7	37.6	37.6	3.05	.93
I enjoy science lessons in this class	18.9	28.1	35.8	17.2	2.51	.99
We should spend more time on science each week	48.3	28.6	14.8	8.3	1.83	.97

N = 1,775

The Cronbach Alpha coefficient of 0.91 (N = 1,775) showed that the scale has a high internal consistency. This, coupled with the results from the factor analysis, determined that it was appropriate to create the Attitude scale from the seven items. This was done by taking the mean so that the resultant variable was scored in a comparable way to the original items. Table 4.9 shows the Attitude to this Science Class scale broken down by year group and gender.

Table 4.9

Mean of the Attitude to Science Class Scale broken down by Year Group and Gender

School year	Gender	N	Mean	Standard Deviation
Year 8	Female	299	2.56	.73
	Male	404	2.62	.77
	Total	703	2.60	.75
Year 9	Female	305	2.18	.72
	Male	340	2.27	.78
	Total	645	2.23	.75
Year 10	Female	209	2.51	.78
	Male	218	2.52	.77
	Total	427	2.51	.77
Total	Female	813	2.40	.76
	Male	962	2.47	.79
	Total	1,775	2.44	.77

The Kolmogorov-Smirnov Test of Normality showed that the Attitude scale was significantly different ($p < 0.001$) to a normal distribution for the overall variable and for each of the genders and school years. Figure 4.7 shows the boxplots for the scale for each group. The plots shows that the difference to the normal distribution is not visibly substantial so both parametric and non-parametric tests were conducted to check for consistency of results. Since they showed the same results, only the parametric ones are given.

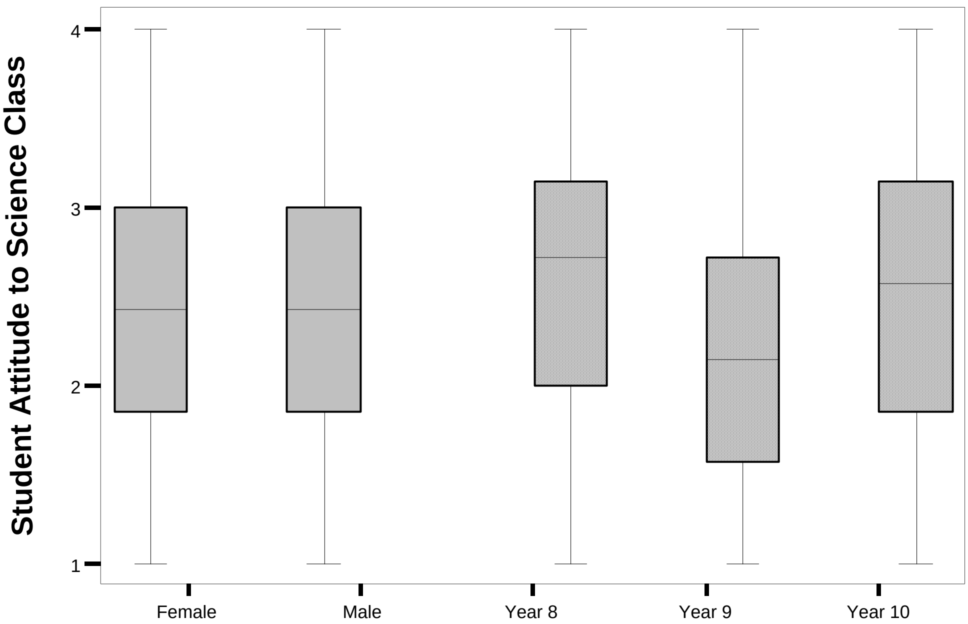

Figure 4.7. Boxplots of the Attitude to Science Class scale for gender and year group.

The mean score for the Attitude scale for the males was higher than for the females (see Table 4.9). Since the original items were scored from 1 to 4, with 4 representing the desirable response of Agree, this suggests that males have a more favourable attitude to science in the classrooms than do the females. The independent samples t test showed the difference not to be statistically significant, however (t (1773) = 1.93, $p > 0.05$).

To compare attitude to science across the three year groups a one-way Analysis of Variance was used. The results showed that there was a statistically significant difference across the groups (f (2,1772) = 42.66, $p < 0.001$). Further post hoc tests (Scheffe) showed that there was a statistically significant difference in the mean score for the Year 9 students to those of both Year 8 and Year 10 ($p < 0.001$). Years 8 and 10 were not significantly different to each other ($p > 0.05$). The Year 9 students had a lower mean score indicating that they had a more negative attitude to science class than the other two year groups. The Year 8 students had the most favourable attitude score (see Table 4.9).

The results of the univariate Analysis of Variance used to test for any interaction effect between gender and year group in regard to attitude to science, showed that there was a significant main effect of year group ($f(2,1769) = 41.96$, $p < 0.001$) but a non-significant main effect of gender ($f(1,1769) = 2.17$, $p > 0.05$). The interaction effect between gender and year group on the perceived equity was also non-significant ($f(2,1769) = 0.42$, $p > 0.05$). The results are represented in Figure 4.8.

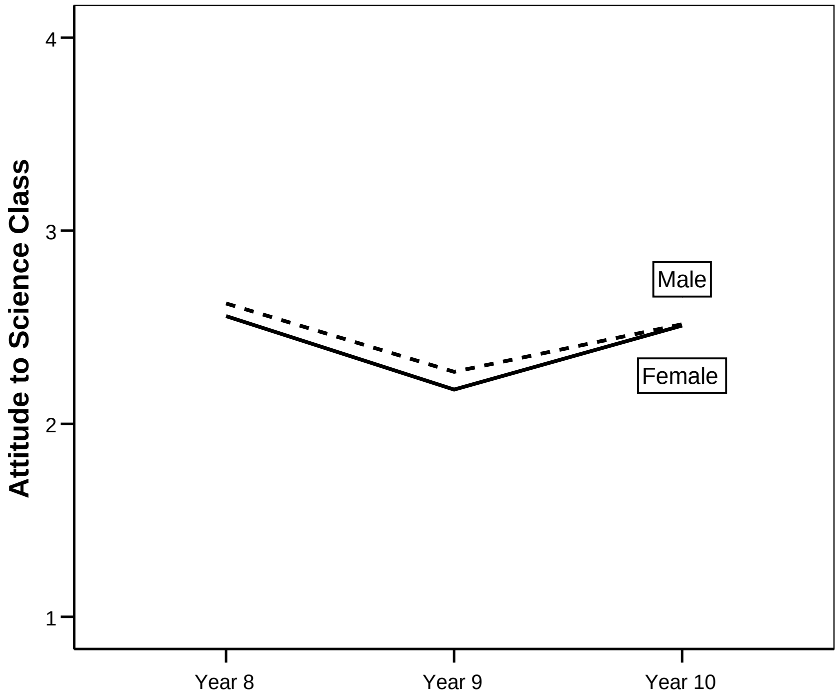

Figure 4.8. Line graph of the interaction of gender and year group on attitude to science.

A one-way Analysis of Variance using the derived gender and year combination groups showed that there was a statistically significant difference in the perceived Attitude scores ($f(5,1769) = 17.80$, $p < 0.001$). Figure 4.9 shows boxplots for the Attitude to Science Class scale for each of the groups. Scheffe post hoc test indicated that whilst the Year 9 females were not significantly different to the Year 9 males ($p > 0.05$), both groups were significantly different to all other groups ($p < 0.001$).

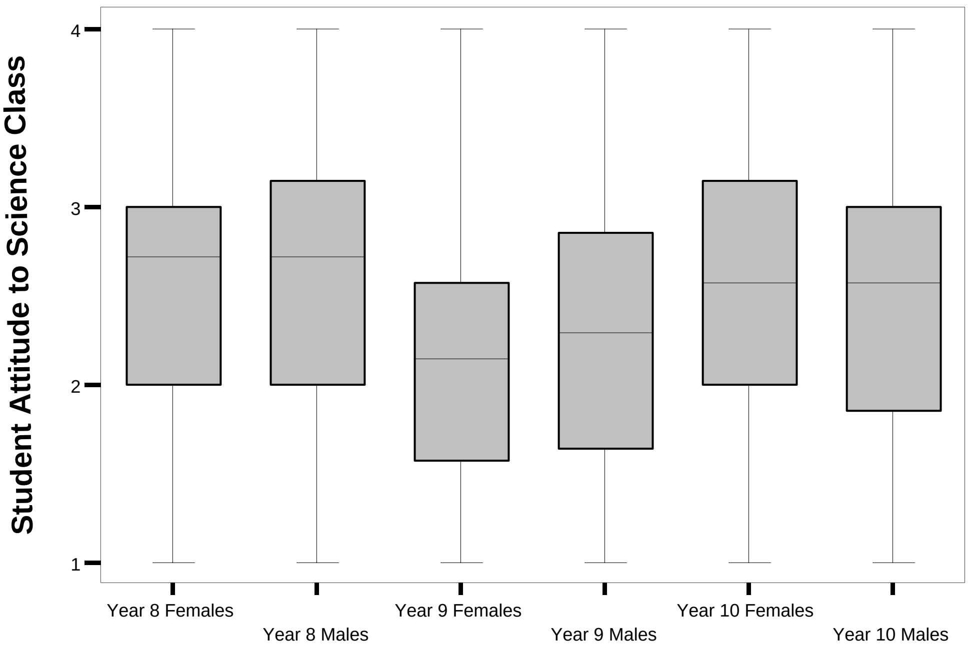

Figure 4.9. Boxplots of the Attitude to Science Class scale for year group and gender combinations.

The mean Attitude scores for the Year 9 females (Mean = 2.18, SD = 0.72) and for the Year 9 males (Mean = 2.27, SD = 0.78) were lower than all the other groups suggesting they had a less favourable attitude to the science class.

4.6 Associations between the Teacher Support, Equity, and Attitude Scales

The Kolmogorov-Smirnov Test of Normality showed that the three scales of Teacher Support, Equity, and Attitude were all significantly different ($p < 0.001$) to a normal distribution. Figure 4.10 shows boxplots for the scales. Whilst the test of normality indicated that the scales are not normally distributed, the large sample size of 1,775 plus the visual checking of the Normal Q-Q plots and the boxplots suggested that the use of a parametric test would be appropriate. To ensure that this was the case, both the parametric Pearson product-moment coefficient and the non-parametric Spearman's rho were used to examine correlations between the scales. Since the results were almost identical, only the parametric ones are given.

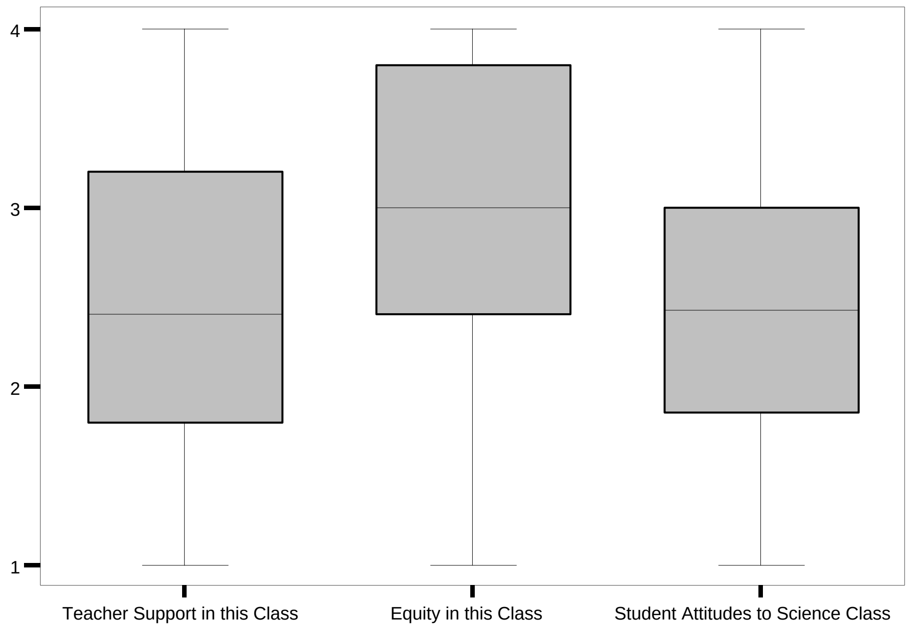

Figure 4.10. Boxplots of the Teacher Support, Equity and Attitude to Science scales.

With the Attitude to Science scale as the dependent variable, the correlation (*r*), reported in Table 4.10, showed statistically significant ($p<0.001$) associations between students' attitude to science class and the Teacher Support and Equity scales. The multiple correlation (*R*) was 0.59, which was statistically significant. The R^2 value of 0.34 indicated that 34% of the variance in students' attitude to science could be attributed to their perception of support received from the teacher and the feeling of equity in the class. Since the associations were positive, the students' attitude to science increases as their perceptions of teacher support and equity increase. The standardized regression coefficient (β), which measures the association when the effect of the other scale is held constant, indicated that teacher support in the class impacted more than perceived equity on students' attitude to science.

Table 4.10

Associations between the Teacher Support and Equity Scales, and the Attitude Scale

Scales	r	β
Teacher Support	0.54*	0.36*
Equity	0.51*	0.28*
Multiple R	R = 0.59*	R^2 = 0.34

* $p < 0.001$ N = 1,775

4.7 Effect of Gender on the Support – Equity – Attitude relationship

To investigate the effect of gender on the Teacher Support, Equity and Attitude associations, a regression analysis was run separately for females and males. The results are given in Tables 4.11. The results suggest that the attitude that females have towards their science class is affected more by teacher support and equity (R^2 = 0.40) than for the males (R^2 = 0.31). For both genders, the associations are positive and statistically significant showing that the students' favourable attitude to science increases as the perception of student support and equity in the classroom increases also.

Table 4.11

Associations between the Teacher Support and Equity Scale and the Attitude Scale by Gender

	Female N = 813		Male N = 962	
Scale	r	β	r	β
Teacher Support	0.59*	0.41*	0.51*	0.32*
Equity	0.55*	0.28*	0.50*	0.30*
Multiple R	R = 0.63*	R^2 = 0.40	R = 0.56*	R^2 = 0.31

* $p < 0.001$

4.8 Effect of School Year on the Support – Equity – Attitude relationship

To investigate the effect of year group on the Teacher Support, Equity and Attitude associations, a regression analysis was run separately for years 8, 9 and 10. The results are given in Table 4.12.

For all three year groups, perceived teacher support and equity are statistically significant contributors to the students' attitude to science. For years 8 and 9, teacher support provides a bigger effect than perceived equity in the classroom. For the year 10 students, however, the reverse is true. Perceived equity in the classroom has more of an effect on attitude than teacher support. The mean score for all three scales of

Teacher Support, Equity and Attitude were lower for the Year 9 cohort than for the other two years.

Table 4.12

Associations between the Teacher Support and Equity Scales, and the Attitude Scale for Year 8, 9, and 10 Students

	Year 8 N = 703		Year 9 N = 645		Year 10 N = 427	
Scale	*r*	*β*	*r*	*β*	*r*	*β*
Teacher Support	0.53*	0.38*	0.57*	0.38*	0.46*	0.25*
Equity	0.48*	0.24*	0.54*	0.29*	0.50*	0.34*
Multiple R	$R = 0.57$*	$R^2 = 0.32$	$R = 0.61$*	$R^2 = 0.37$	$R = 0.53$*	$R^2 = 0.28$

* $p < 0.001$

4.9 Other Learning Environment Scales on the Questionnaire

As shown in Table 4.2 previously, the learning environment section of the questionnaire comprises five scales. They are Teacher Support, Equity, Task Orientation, Student Cohesiveness, and Involvement. This section reports the contribution that all the scales make to the dependent variable of Attitude to Science. Table 4.13 shows the mean and standard deviation for each scale.

Table 4.13

Descriptive Statistics for the Learning Environment Scales

Scale	Mean	Standard Deviation
Teacher Support	2.49	0.86
Equity	2.99	0.83
Task Orientation	3.04	0.70
Student Cohesiveness	3.18	0.69
Involvement	2.49	0.73

N = 1,775

In Table 4.14, the Pearson correlation coefficient (*r*) shows the strength of the correlation between each scale and Attitude to Science. All of the scales were positively correlated with attitude. Teacher Support was the strongest ($r = 0.54$) while Student Cohesiveness was the weakest ($r = 0.27$). The standardised regression coefficient (β) shows the level of impact that each scale has on attitude when the effect of the other scales is held constant.

Table 4.14

Associations between the Learning Environment Scales and the Attitude Scale

Scales	*r*	β
Teacher Support	0.54*	0.29*
Equity	0.51*	0.18*
Task Orientation	0.49*	0.25*
Student Cohesiveness	0.27*	-0.06
Involvement	0.41*	0.11*
Multiple R	$R = 0.63$*	$R^2 = 0.40$

* $p < 0.001$, N = 1,775

Four scales were positively associated such that students' attitude to science improved as they experienced more teacher support, equity, task orientation and involvement.

The level of teacher support had the most impact on the students' attitude to science but all scales were statistically significantly associated with the attitude score.

4.10 Summary

Data from 1,775 students located in schools in the Australian Capital Territory, Queensland, and Western Australia were analysed to investigate the impact that teacher support and equity may have on the students' attitude to science. The students were from years 8, 9, and 10.

Factor analysis and reliability analysis confirmed the scales of Teacher Support, Equity, and Attitude to Science. Derived variables were created for each scale by taking the mean score of the variables in each one. Means, rather than sums, were used so that the resultant scores related directly to the coding of the contributing questions. Each question had been answered on a 4-point scale with 1 representing the lowest response level and 4 representing the highest. Comparisons of the scales were done for males and females, years 8, 9, and 10, and for gender and year combinations.

The software package SPSS was used for the analyses. Gender comparisons were performed using Independent Sample *t* tests, and the corresponding non-parametric Mann-Whitney test. Year group comparisons were performed using the Oneway analysis of variance procedure, and the corresponding non-parametric Kruskal-Wallis test. The derived gender and year group comparison also used the Oneway and Kruskal-Wallis tests. Parametric and non-parametric tests were run because the data were not always normally distributed. In all situations, however, the results were very similar so only the parametric ones were reported as they related to the actual data, rather than to rankings for the data.

The *t* test results showed that females rated the scales of Teacher Support and Equity more highly than did the males but the males had a more positive attitude to science than did the females. The Oneway results showed that Year 9 students were considerably less positive than those from years 8 and 10. Of the three scales, Equity received the highest rating across all groupings (Mean = 2.99, SD = 0.83), while Attitude received the lowest (Mean = 2.44, SD = 0.77). Figure 4.11 summarises the results presented previously in relation to each of the scales

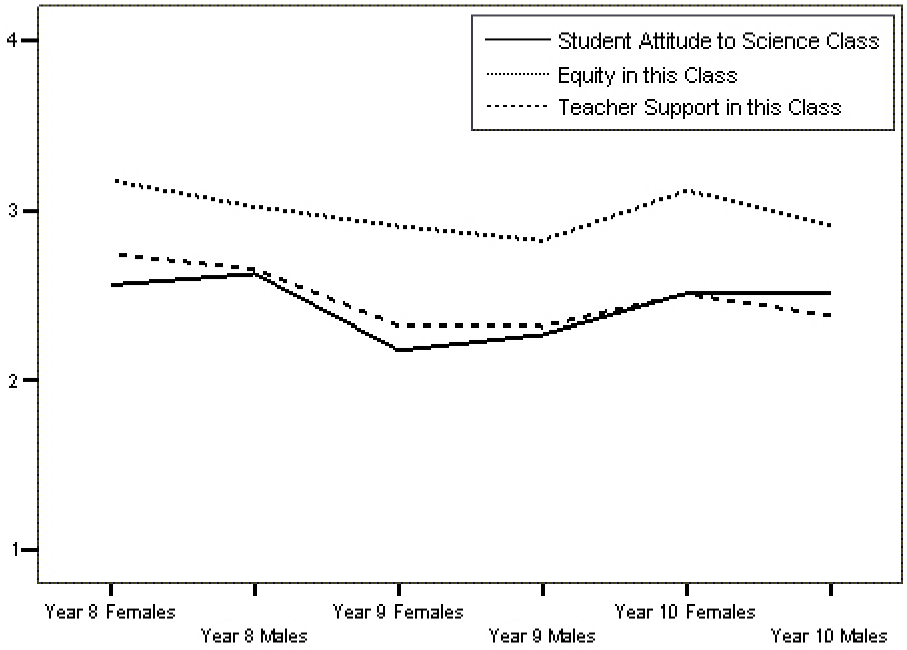

Figure 4.11. Line graph showing the means of the Attitude, Teacher Support and Equity scales by gender and year group combinations.

Teacher Support, Equity, and Attitude to Science were tested separately for any interaction effect between gender and year group. The factorial Analysis of Variance showed that the interaction effects were non-significant on the three scales. Table 4.15 summarises the results presented previously in relation to each of the scales.

Table 4.15

Interaction effect of Gender and Year Group with each Scale

		f	
Scale	Gender	Year group	Gender * Year group
Teacher Support	3.33	34.70 *	0.80
Equity	13.79 *	13.75 *	0.75
Attitude to science	2.17	41.96 *	0.42

$p < 0.001$, N = 1,775

Regression analysis showed statistically significant and positive associations between the students' attitude to science and the Teacher Support and Equity scales. The students' perception of teacher support and equity account for 34% of the variance in attitude, with teacher support having the greatest impact (β = 0.36). These results were consistent when tested for males and females separately, and for each of the year groups.

Given that there is a need for students to have a more favourable attitude to science if they are to continue studying it in post-compulsory education, this positive association has a valuable practical and educational significance for teachers. An increase in the simple interpersonal actions of the teacher going out of their way to help the student; considering the students' feelings; talking with the students; being interested in students' problems; and moving about the class to talk to the students (the items that make up the Teacher Support scale) should bring about a more positive attitude to science.

CHAPTER FIVE

INTERVIEWS WITH TEACHERS

5.1 Introduction

Education is constantly under review and undergoing change. Whether it be the introduction of a curriculum framework, outcomes based education, or the introduction of middle schools. There are also a number of stakeholders in any situation and those stakeholders often view situations and changes from different perspectives.

Research into students' attitude to science, especially with a focus on teacher support and equity in the classroom, cannot ignore the teacher perspective. Whilst the information gathered and described here was not subjected to formal qualitative analysis, the comments and opinions expressed by the three teachers and one pre-service teacher provided a backdrop for the analysis of the data provided by the students.

Whilst none of these teachers were involved in the other aspects of this study, so their responses couldn't be used directly with those expressed on the student questionnaire, the information was used to give insight into perceived attitudes in relation to teaching methods used and the general science environment in the schools. The responses established how teachers perceived the science learning environment at the different stages of their own experiences, thus addressing research question 6.

The views expressed by the interviewees have been summarised according to the questions asked and are presented in Tables 5.1 to 5.7.

The pre-service primary school teacher (PST1) was a female, 20 years of age, and in her final year at university. She intends to go into the government school system. She described the situation experienced during her last practicum that was at a government school in the southern suburbs of Perth, Western Australia (WA). The school had approximately 300 students in kindergarten, pre-primary, and Years 1 – 7. There were 13 teachers in the primary school.

The current primary school teacher (PT1) was a male, in his early 60s and taught at a non-government metropolitan school. The school overall had years K to 12, but he taught in the primary school only. He had been at the school for 20 years and had been involved in a teacher-training program prior to that. He had also taught at the high school level both in Australia and as an exchange teacher in Canada. Whilst his current role was as a mathematics specialist teacher, he had been a general classroom teacher and, as such, had been responsible for the teaching of science to the students. The primary school was co-educational with 390 students at the primary level with 20 teachers. Only 60 of the students were girls. Of the 72 Year 7 students, only nine were girls. Special care was taken to ensure that the girls were not disadvantaged because of their minority status. Academically they did equally as well as the boys.

The first secondary school science teacher (ST1) was female, in her 40s and taught at a large co-educational government high school in the suburbs of Perth, WA. The school covered Years 8 to 12, had approximately 1,800 students, and approximately 20 science teachers out of a teaching staff of 150. Some of the science teachers worked full-time, others part-time. The school had a very strong science focus and both staff and students have won many science awards. The school had an academic talent program for science and mathematics, and science and humanities combinations and students came from all over WA to participate.

Teacher ST2 was female, in her 30s and taught science in a college which catered only for students aged from 11 – 15 years. The college was the first purpose built facility in WA for middle schooling and 2006 was its fifth year of operation. The learning environment was quite different from the traditional class structure but ST2 had also taught in the more conventional ‘class’ arrangement. The students in the college were divided into communities rather than classes, with one community covering Years 6 and 7, another covering Years 8 and 9, and a separate one for Year 10. All 120 students were grouped together in one large open room. Placement in a community was as dependent on academic level as year level. Teams of teachers taught different subject areas, and science had a larger number of teachers than any other subject. The older aged students (equivalent to Year 10) were taught separately in preparation for moving to a senior high school or TAFE for ongoing education.

5.2 Interview Questions and Responses

5.2.1 Teachers' own Science Education

The first question asked related to the interviewees own science education to establish their backgrounds and to gain an understanding of why different people decide on their particular career paths. Table 5.1 shows the responses that were given. Knowing the backgrounds also allowed any later comments to be put into a relevant context.

Table 5.1

Responses Regarding the Interviewees Own Science Education.

Teacher	Response
At what age do you remember starting to learn science?	
PST1	Don't remember doing any science before Year 5. Did TEE Human Biology because didn't understand Physics or Chemistry.
PT2	Very little science at Primary School except for some nature study. No physical sciences at all. Did Physics and Chemistry at High School.
ST1	Started in High School.
ST2	Nothing before Year 6 or 7.
How was the science taught?	
PST1	Did some things in the playground but classes mostly chalk and talk (C&T), copying notes from the board. Boring.
PT2	Did a lot of reading and writing – mostly C&T. Not very good at science. Don't remember it favourably.
ST1	Traditionally taught with teacher at board with students taking notes. Had specific science classes.
ST2	Mixture of C&T plus some outings. Learned better through C&T but remember outings more.
When did you decide to become a teacher?	
PST1	In Year 10 because lots of family members are teachers and seem to enjoy it.
PT2	After realising that couldn't afford to do Law degree, did teaching to earn enough money to go back to Uni. Enjoyed teaching so much, never did law.
ST1	After 1st year Uni. Having realised would never achieve medicine.
ST2	In Year 1 because had a very positive teacher.

When did you decide to become a science teacher?	
PST1	Did science in Pracs because believed could improve on own experience.
PT2	Thought Primary teaching would be easier initially, but tried Secondary teaching & found it less rewarding.
ST1	Deciding to teach and to teach science happened at the same time.
ST2	In Year 11.
Why did you decide to become a science teacher?	
PST1	Important for children to have good science understanding to make transition to High School easier.
PT2	Majority of teaching was as general classroom teacher that includes some science lessons. If anything had to go, it would be science.
ST1	Good at all science and enjoyed it.
ST2	Decided on Human Biology because interested in it. Looked at all old school reports and realised had always been good at science.
Describe your teacher training with regard to science	
PST1	As a PST told have to teach science, but only done 1 unit on how to teach science, all other units now relate to content.
PT2	Paid lip service to science because didn't have a good background in it. Over time realised that was unfair, found out more about it and began to teach it properly. Assumption is that a Primary School teacher can teach anything, or that they'll go and learn about it for themselves. Don't get that science background as part of training.
ST1	Did teacher training to be a science teacher. Did specific units for that, theory and practical. Did Pracs at different places. Taught content of subjects and a little delivery. Not really taught classroom management.
ST2	Did Human Biology degree at Uni, taught there for while then did Dip Ed in secondary school science.
How long have you been a science teacher?	
PST1	
PT2	Been involved with teaching for over 40 years.
ST1	Been a science teacher for 21 years.
ST2	Been school science teacher for 11 years.
How many schools have you taught at?	
PST1	Have done Pracs at 2 schools
PT2	Have taught in many different situations.
ST1	Have taught at 5 schools.
ST2	Have taught at 6 schools.

5.2.2 Science in the Interviewees' current School

The second part of the interview asked about science generally in the teachers' current school. Since the four respondents were from quite different types of school and levels of experience, the information was used to gauge differences in the approach to science in the variety of establishments. The responses are summarised in Table 5.2. Because of the concerns raised in the 2001 report by Goodrum, Hackling, and Rennie that the number of students continuing their science education beyond the compulsory education years was declining, the question also asked about whether science teachers encourage ongoing learning.

Table 5.2

Descriptions of Science in the Interviewees' Current Schools

Teacher	Response
Is science considered an essential area of study or just part of the curriculum?	
PST1	Definite part of the curriculum. Class generally did maths, language & sport because they were class teacher's preference. When observing, teacher taught science as C&T with practical 'if there was time'.
PT1	Primary Investigation used at all levels and then most staff have gone on to develop their own things. Curriculum person who tracks science through the Primary School to make sure skills are being developed, not repeated. Taught better in some grades than others.
ST1	Very prestigious science school. Academic talent program for science. School admin mostly former science teachers so strong emphasis given. Money has been allocated to remodel science facility.
ST2	Have learning area outcomes but can teach to them in any way. Science taught as separate entity and as integrated subject.
Which science subjects are taught?	
PST1	Different topics.
PT1	Lot of teachers are frightened of science so they teach what they know.
ST1	General science in 8-10, then have Physics, Chemistry, Senior Science, Biology, Human Biology. Used to have Geology but teacher left.
ST2	Teach to content required for a 'theme' rather than Chemistry or Physics or whatever. Traditional subject areas in Year 10.
General characteristics of the science teachers	
PST1	Teacher close to retiring age so not interested in using new teaching methods.
PT1	Majority of the staff have 10-20 years experience, some with a lot more. Very few young teachers as school likes to employ experienced teachers. Science taught equally across the experience range.
ST1	20 teachers. Range of ages and experience, but noticed a couple of young ones this year. Low turnover of staff because prestigious school to be at for science teachers.
ST2	10 teachers. Variety of ages and experience (eg old Heads of Departments plus graduates). More science teachers than for other subjects. Generally happy with different approach to teaching.

What science knowledge do the students take with them from Primary School?	
PST1	Students have basic science knowledge to take to High School. Students won't have got a lot out of science they did at Primary School. Primary School and High School science very different, so not necessarily help them.
PT1	Mostly deal with the natural world and that learning flows over into other things later. Hope students learn skills rather than pure content. Go to High School with sense of science in everyday living, scientists place in society generally.
ST1	Real mix of knowledge. Better than it used to be because of TV science programs. Year 8 teachers have to start from scratch with students – presume no knowledge. PEAC students would have seen it before.
ST2	Notice knowledge gaps in intake to Yr 10 as coming from different themes in the 8/9 community. Gaps also because one group didn't have strong science teacher. In 6/7 and 8/9 communities, expected to teach everything so if not confident with topic can cause problems for students.
Is encouragement given to choose science as a TEE subject?	
PST1	TEE not relevant at this level but should include science in all years because children should be doing it.
PT1	Hopefully students see the role of science in life generally and are encouraged to be part of the discovery process in the future.
ST1	Year 10 students encouraged to continue but based on what uni / career they are heading for. No one would be dissuaded from doing science if they really wanted to – even if weak at it. Mixture of students gone on to do science in further studies.
ST2	Encourage science as life skill context rather than 'subject'.

5.2.3 Interviewees' own Science Teaching

The third area of questioning related to the way the interviewees taught science themselves. This was to establish what happened in practice and whether that practice related to their experiences as students. Table 5.3 gives a summary of the responses.

Table 5.3

How the Interviewees Teach Science.

Teacher	Response
How many science classes do you teach per week at all levels?	
PST1	During Prac did one session per week.
PT1	Year 7s have 3 periods per week for science topics.
ST1	5 classes for 4 periods a week each (20 hours).
ST2	4 classes, 3 times a week, for 90 minutes each.
What science subjects do you teach?	
PST1	I did Balance topic.
PT1	Found programs that gave a good base and developed them from there for any topic.
ST1	Physics, Chemistry, Human Biology, Biology, Physical Science.
ST2	Teaching investigating at the moment. Move on to Chemistry and possibly Genetics.
How do you teach those subjects?	
PST1	Had to use class teacher's method and equipment. Not very imaginative or fun. Class teacher needed to be in control and couldn't equate noise with learning so not much practical work done.
PT1	Hands on.
ST1	Started out with C&T but changed after studying how to teach, student learning, and learning environments. Became more of a facilitator for learning. Some students preferred C&T. Others liked the hands-on.
ST2	Use hands on approach doing fun things. Use C&T when necessary.
Do you teach differently for the various year levels?	
PST1	Would have taught younger students differently.
PT1	Yes.
ST1	Yes.
ST2	Teach all communities in the same way.
How do you teach differently?	
PST1	Fun ways as introduction to science.
PT1	In lower classes use themes so include science as appropriate. Structured in Year 7.
ST1	Would 'teach' earlier groups, but give responsibility for learning to older ones.
ST2	Teach to ability and task at hand.

5.2.4 Interviewees' Perceptions of Students' Attitude to Science

Having established the background information for each of the teachers, the next question asked about their perceptions of the students' attitude to science. The responses are summarised in Table 5.4.

Table 5.4

Students' Attitude to Science as Perceived by the Teachers

Teacher	Response
Do students tolerate science or is there real enthusiasm to learn?	
PST1	Class tolerated science, but also enjoyed some aspects of it. Teacher underestimated the ability of the students so they weren't stretched and got bored.
PT1	Primary students are excited about science because of what they see on television. Easy to maintain enthusiasm with good teaching style and keen approach.
ST1	Tolerate science but turned off by way its taught, or too much reading and writing. The average student has no enthusiasm for science. Students who are part of science program have real enthusiasm.
ST2	No real enthusiasm. Lack confidence as not a strong subject in Primary School. Not enough trained primary science teachers so they lack confidence too. Students need to be switched on to subject matter. Students can't see the relevance of science. Don't see the science in 'just being a mechanic'. Terminology turns them off. Attitude also affected if they don't get on with the teacher / don't like their approach to students or subject.
Do you notice a difference in attitude between boys and girls?	
PST1	No difference – surprisingly as there were differences in my time. Boys understood concepts better so girls let them get on with it.
PT1	No difference in their enjoyment or attitude. Big difference in learning style however. Boys learn by touching and experience. Girls are meticulous and good recorders. They do learn differently – excel at different tasks.
ST1	Definite difference. Boys want to be 'blowing things up'. As boys mature, more able to absorb complex ideas, more focussed. Girls are compliant early on, read, write, finish tasks then forget it. Boys better at maths and physics at top end of school. Fewer girls choose science at top end – all male teachers put them off. Still a stereotype that science is male area.
ST2	Not noticed an attitude difference.

Do you notice a difference in attitude between the year levels?	
PST1	No experience of different year groups.
PT1	No difference in enthusiasm. Can do almost anything with Year 1s – easy to get and keep keen – naïve as to expectations of education, just think its fun thing to do. Harder to enthuse in Year 7s .
ST1	Very keen in Year 8 because all new area. Year 9s switch off. Year 10s can see need in what they want to do so attitude changes. Those in gifted program generally have a different attitude – more likely to go on with science beyond schooling.
ST2	More confident in themselves by Year 10 so attitude a bit different. No general attitude difference. Approx 60% go on to SHS so must do at least one science subject for TEE.

Based on student enthusiasm, where would science sit in a league table of subjects?	
PST1	About half way – below sport, health, maths. Health in context of science generally but not in way it was used at this school.
PT1	Tables would differ for each student. Boys would put sport first. Science would come before maths but probably behind English. It would be fairly high.
ST1	Normal students would put science in the middle, below sport and elective subjects or practical subjects. Gifted children would put it at the top because they love it and are good at it.
ST2	Close to the bottom. See everything else more important, more relevant. Could live without science. Don't see science in real life contexts.

5.2.5 The ideal Science Class Environment from a Teachers' perspective

Teaching and learning environments are often constrained by finances available and the current trends in education. Question 5 of the interview sought to find out what the ideal environment would be from the teachers' perspective. The points discussed included characteristics of the teacher since student – teacher interactions are the main area of interest in this study. The responses are given in Table 5.5.

Table 5.5

The Ideal Science Class Environment from a Teachers' Perspective

Teacher	Response
How would science be taught, given a free rein?	
PST1	If specialist, would love groups of kids in class with each group doing something different but as part of same topic (round robin type of arrangement over several weeks).
PT1	Specifically designated teaching area. Plenty of equipment readily available. Equipment that would encourage teachers to teach science.
ST1	6-8 computers as learning tools only. No rows of seats. Seating groups around the rooms. Space for ongoing experiments so no packing up at the end of the hour. Telescopes for night use. Lots of student work around the walls. Currently sit in rows then go to labs for experiments – not inspiring places.
ST2	Teach to context. Big room with technology. Collaborative learning. Lab/practical area.
What special attributes would the ideal science teacher have?	
PST1	Be open to using different methods. Understand that 'noise' can equate to learning.
PT1	Ideal teachers would love science themselves. Have some knowledge. Be naturally inquisitive. Like hands-on approach. Keen on discovery type of approach.
ST1	Ideal teacher would be enthusiastic and convey love of science. Need to communicate well with students. Full knowledge to answer questions.
ST2	Teach relevant to students' interest area or need. Teacher needs to be flexible and adaptive, and know or be confident about everything.
What teaching skills would a science teacher demonstrate?	
PST1	Students don't like to embarrass themselves by asking questions so need to be aware of each student.
PT1	
ST1	General skill of being good at explaining things. Be receptive to questions from students.
ST2	Teacher needs to be open but firm. Able to put in academic rigour. Be patient with the students.

5.2.6 The ideal Science Class Environment from a Student perspective

Since the four teachers had been asked to visualise their ideal science teaching environment, it was also appropriate to ask them what they thought the students would describe as their ideal science learning environment. The responses are given in Table 5.6. If, indeed, the 'ideal' was considerably different to the 'actual', a commensurately poor attitude could be expected.

Table 5.6

The Ideal Science Class Environment from a Student Perspective

Teacher	Response
How would students learn science, given a free rein?	
PST1	Hands on. Minimal writing. Fun. Not tested. Range of activities. Do things relevant to life situations but like odd-ball things too, for fun.
PT1	Science lab type of environment. Have visits to places like Sci-Tech or labs, museums etc. Want to get their hands on things.
ST1	Wireless computers for every student. More hands-on. More equipment.
ST2	Do topics they are interested in. Like structured environment.
What special attributes would the ideal science teacher have?	
PST1	Patient, approachable, friendly but still have authority over them, fun.
PT1	Ideal teacher would challenge the students. They would know what they were talking about.
ST1	Know all the answers and teaches exciting things. Younger. Probably male.
ST2	Teacher who takes on what students want to do. Teacher who is willing to negotiate the program.
What teaching skills would a science teacher demonstrate?	
PST1	Same as above.
PT1	
ST1	Fair.
ST2	Teacher who is open, listens.
Does the presence or absence of those ideal characteristics affect students' attitude?	
PST1	Will respond according to teacher's style.
PT1	Attitude will only be affected if really disappointed by the teacher and their style.
ST1	Definitely have preconceived ideas of their 'ideal' teacher so could be put off. If teaching style turns out to be OK, students could change ideas.
ST2	Students are very demanding of teachers and if they don't get what they expect then attitude can be affected.

5.2.7 Science Learning Environment in general

Prior to the interviews taking place a general description of the current research was given. Deliberately, the thesis title and the reasons for conducting the study were withheld so that responses were not biased. The final part of the interview was conducted after giving both. Questions were then asked with the particular emphasis on declining numbers of students taking science subjects, and the possible impact of teacher support and equity on attitude to science. Table 5.7 summarises the responses.

Table 5.7

The Science Learning Environment in General

Teacher	Response
What difference is there between science now and in your school days?	
PST1	Current students more willing to give science a go. Better attitude because new content out and teachers have to use it and address it so children exposed to science.
PT1	Today's students much more aware of science. Have a more sophisticated understanding.
ST1	Students see science as necessary evil – one of the core subjects expected to do. Currently more consumerism than it used to be – bigger potential if they persevere. Techniques are transferable to other areas but children don't pick up on that.
ST2	Peer group disliked science but might have liked it under current teaching methods.
Do you agree that there is cause for concern about the drop in student numbers choosing science after Year 10?	
PST1	
PT1	Concerned. Hard subject area that is score driven and students will go for a less demanding course that they can do well in. At High School level only the brightest students take on physics, chemistry etc because they are seen as too hard. Average students told to choose subjects they can do well in because schools under pressure to perform too.
ST1	
ST2	Not surprised in drop of student numbers even with change in teaching style. In own student days 96% did TEE and so did some science content. Now drop in numbers doing TEE as more flexibility therefore more choice. Year 12 is not the end – options as mature age students. Do TEE subjects that students know they need – Maths and English – then things that are relevant to them.
What could be done to reverse the trend?	
PST1	
PT1	Need to encourage students to accept a challenge and try the harder subjects. The magic pass score is not the be all and end all.
ST1	Need to sort out the teachers. Need Primary teachers who are competent and confident. Students should be alerted to 'life skill' rather than just 'science'. Science not seen as big money earner, not glamorous occupation so students don't take it up.
ST2	

What changes, if any, would you make to the training of teachers with regard to science?	
PST1	Universities need to give student teachers ideas on how to teach science effectively. Need to be taught classroom etiquette, and appropriate treatment of students whilst training (not done yet anyway)
PT1	90% of professional development goes into literacy, why not a fair proportion into science? If teacher training hasn't improved since his day, then shudder at the thought – it had inadequate covering then and probably still has.
ST1	Need to attract good science teachers and train them adequately. Need to have good ones in Primary School to sow the seeds at a young age so that students are enthused and go all way with science. Need strong lead from administration to make it happen.
ST2	More needs to be done at Primary level. Need compulsory unit to build up confidence in science. Learn different teaching strategies for science – not just C&T for content. Not given pointers as to how to relate to the children. Need a method to build confidence in new teachers.
General comments	
PST1	Don't have enough classroom experience yet to comment on specifics of thesis title. Teachers are getting more of an idea of what is expected from science through OBE so science education is improving. Hope for the future of science starts with education at the primary level.
PT1	Amount of teacher support definitely affects attitude. Must support all students in the same way and to same degree – not just favour those who are good at the subject. Must provide students with confidence generating situations so all students will contribute to class and ask questions. Negative teaching attitude creates a negative learning attitude.
ST1	Lots of teachers don't realise how students perceive them. Maybe should do student satisfaction questionnaires at the end of each term – teachers would be shocked at results. Need equitable treatment of the teachers too – as female in male dominated department it is hard.
ST2	What students want may be knowledge or assistance or encouragement. Teachers expected to teach as if all students can do everything but that isn't always the case. Support needs to be relevant to the individual so should include being allowed to fail as an option. Equitable treatment of students should come from understanding their strengths and weaknesses.

5.3 Summary

The teachers provided valuable insights into attitudes and perceptions of science both in their own student days and in their current teaching. Despite the range in their ages from 20 to mid 60s, it seemed that the art of teaching science in a manner that enthused the students had not changed over the years. Both the oldest and the youngest teacher expressed disappointment with how they had been taught, and said that it had affected their attitude to science. The difference between them was that the youngest one had realised the deficiency early and was determined not to make the same mistake with her students. The older teacher had come to the realisation, but had started to address it much later in his career.

The general feeling among the teachers interviewed was that students' memories of science at the primary levels was likely to be of outings or hands on experiences. Few students remembered or enjoyed the theory side of the subject, if it had been taught it at all. The inconsistent approach at primary school level meant that year 8 science teachers had to presume that students had no science knowledge, and start from the beginning again. This has the potential to turn off students who had received science teaching at primary school, and put extra pressure on the year 8 teachers.

When asked if science was tolerated by the students or was there a real enthusiasm for the subject, all the teachers thought that science was tolerated only. Teacher PT1 thought that primary school students were excited about science because of the way it was generally portrayed on television, but that the excitement had to be maintained by a positive teaching style. The other three teachers related the lack of enthusiasm to the method of teaching and to the lack of confidence often displayed by primary school teachers.

When asked where students would rank science in relation to other subjects, they all agreed that it would be well down the list. Three of the teachers said that sport would be above it, along with mathematics and English. Coming from a science specialist school, however, teacher ST1 thought that the gifted students would rank science number one because they loved it and were good at it. The comments by teacher ST2 probably highlight the concerns raised in the DETYA report (Goodrum et al, 2001). ST2 said that students see everything else as more important, more relevant. Students don't see science in real life contexts and could live without it.

The teachers thought there was a difference between females and males in how the students actually learn science, but there was no difference in the students' attitude to the subject. Teacher ST1, however, expressed the view that fewer female students chose science in the upper part of the school because they perceived science to be a male area. Teachers PT1, ST1, and ST2 felt that there was no difference in attitude to science between the year levels but that the change from primary to high school prompted a rekindling of enthusiasm. In primary school, Year 1 students were keen and enthusiastic because any science learning was new and usually fun. By Year 7 this tapered off. In Year 8 the interest picked up again because the subject may be totally new, or approached differently, but then tapered off until Year 10. After that, the students were more confident in themselves, could perhaps see the use for science in their future choices, and were perhaps more generally aware of the role of science in everyday life.

All agreed that teacher actions or inactions would affect the students' attitude to any subject, not just science. Students needed to feel able to ask questions without criticism and receive the help that they needed to progress. It was not appropriate behaviour for a teacher to favour the more successful students, or those who displayed a positive attitude to science.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND IMPLICATIONS

6.1 Introduction

This chapter draws together the information presented earlier and looks at possibilities for the future. A review of the research questions, what method and analysis was used to address each one, and what was found is presented in Section 6.2. What the research means for each of the research questions and also how this compares to the literature is discussed in Section 6.3. The appropriateness of the research method is discussed in Section 6.4 along with the impact this may have had on the results. Section 6.5 sets out implications of the findings for teachers and teaching, for teacher training, for the students, and finally for the situation of the declining interest in science.

6.2 Summary of the Research

In 2001, DETYA published a report prepared by Goodrum, Hackling, and Rennie that described the situation of a reduced interest in science as shown by the declining number of students choosing to take science subjects in the post-compulsory years of schooling. The report also described the impact this lessening interest could have on the social and economic future of Australia and, indeed, the future generally since the decline is a phenomenon also experienced in other western countries.

In Australia, the teaching and learning of science in Primary schools is not done consistently and so the students are often faced with a totally new subject area when they enter high school. At the same time, they are experiencing the developmental stages of early teenage years with the physical and mental changes that occur at that time. They also have the challenge of moving from a nurturing and, perhaps, protective Primary School environment with one main teacher to a less personalised, subject focussed, multi-teacher environment at the same time. Previous research on science learning environments has suggested that the role of the teacher within the learning environment has a vital role to play in relation to the attitude of students to learning in any subject area. That role can be particularly important at the time of considerable change that the student is experiencing in the lower High School years.

In 2004, the ARC began funding a Discovery project that investigated the concepts of students' perceptions of assessment, perceptions of their learning environment through teacher–student interactions in the classroom, and their attitude towards science. Data from that study have been used for this thesis. Students in the Australian Capital Territory, Queensland and Western Australia completed a questionnaire that used the SPAQ to gather information on assessment, a modified version of the WIHIC to gather information on the learning environment, scales from the TOSRA to gather information on students' attitude, and some demographic questions to enable comparisons between age and gender. The questionnaire is given in Appendix A. Although 2,206 students responded initially, this was reduced to 1,775 in the final database. The removed cases were either incomplete, or from school years not applicable to this current study. The assessment data were also not applicable to this study.

The specific areas of teacher support and equitable treatment of students in the classroom have been focussed on, as they are an essential part of the role of the teacher. Changes in those areas could impact directly on the attitude of the students and could be brought about by teacher awareness rather than direct teacher training.

The statistical package SPSS was used to analyse the quantitative data. Factor and reliability analysis confirmed the scale structures of the learning environment, and attitude sections of the questionnaire. As a result, the scales of Teacher Support, Equity, and Attitude were created. This was done by taking the mean score across the items constituting those scales. Testing of each of the scales showed them to be significantly different to a normal distribution ($p<0.001$) but the large sample size (N=1,775) and obtaining similar results from the use of parametric and non-parametric statistical tests prompted the decision to only report the parametric results since these compare mean scores rather than mean ranks and are easier to relate to the real data.

Before addressing the specific research questions, gender comparisons and year group comparisons were made for each of the scales of interest. A new variable was created that was a combination of gender and year group allowing more detailed multiple comparison tests to be used. The mean scores for each of the groups for Teacher Support, Equity, and Attitude are given in Table 4.5, Table 4.7, and Table 4.9, respectively. A summary of the comparisons is given in Table 6.1.

The statistical analyses showed that while the females perceived more teacher support and equity than did the males, their attitude towards science class was lower. The difference in the Equity scale was the only one that was significant.

Year group differences were statistically significant for all scales with the Year 9 students returning the lowest scores for each one. This was confirmed by teacher ST1 who commented that, in her experience, Year 8 students are keen because science is a relatively new area, Year 9 students ‘switch off’, and Year 10 students begin to relate science to what they want to do in later life bringing a change in attitude.

Using the derived gender and year group variable, there was a significant difference across the groups on all three scales. In particular the Year 8 females, the Year 8 males, and the Year 10 females perceived more teacher support and equity than did the other groups. Both the Year 9 females and the Year 9 males had more negative attitudes than did the other groups.

Table 6.1.

Comparisons of Gender, Year Group, and Gender Year Group Combinations of Teacher Support, Equity, and Attitude

Scale	Gender (t)	Year Group (f)	Gender and Year Group combination (f)
Teacher Support	1.30	33.88**	14.47**
Equity	3.40*	12.84**	8.08**
Attitude to Science	1.93	42.66**	17.80**

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

Analysis was then done to answer the research questions. The first question asked if the students' perceptions of teacher support had any effect on their attitude to the science class. The second question considered the impact of equitable treatment in the classroom on attitude, while question three concerned the combination of teacher support and equity and the impact on students' attitude. Correlational analysis was used to answer them. Using Attitude as the outcome variable, regression analysis showed that both teacher support and equity were statistically significantly associated with the students' attitude to science class ($p<0.001$). Since the correlations were positive, the results suggest that attitude becomes more positive as the perception of teacher support and equity increases. Furthermore, 34% of the variance in attitude was shown to be attributable to support and equitable treatment from and by the teacher with teacher support having the most impact ($\beta=0.36$).

Research question 4 required the regressions to be repeated for the female and male students separately. The results showed that, for both genders, the associations between teacher support and equity were significantly and positively associated with attitude ($p<0.001$) but that the impact was greater for the females ($\beta=0.40$) than for the males ($\beta=0.31$).

Repeating the regressions again for each of the year groups allowed research question 5 to be addressed. For each year group, teacher support and equity were significantly and positively associated with attitude ($p<0.001$). For years 8 and 9, teacher support provided a bigger effect on attitude than equity did, but this situation was reversed for the year 10 students. The mean score for all three scales of Teacher Support, Equity and Attitude were lower for the Year 9 cohort than for the other two years. This could be explained by the increasing difficulty of the subject material coupled with the lack of maturity of the students, causing them to feel insecure and isolated from the staff and hence give lower scores. By Year 10, the students have matured and are perhaps more accepting of the distance between them and the teachers, causing the scores to increase but not to the levels given by Year 8 students.

The quantitative data collected through use of the student questionnaire were supplemented by information gathered from interviews conducted with one pre-service teacher, a Primary School teacher, and two High School teachers. They ranged in age and experience, and taught at different types of schools. They were chosen because they were known to the researcher and came from diverse educational situations. The teachers provided information about their own science education, science education in their current schools, the science teaching that they do, their perceptions of the students' attitude to science, and science teaching and learning in general. The final research question, question 6, considered how teachers perceive the science learning environment, with particular reference to teacher support and equity in the classroom, and the students' attitude to science.

With the exception of Science Teacher 1 (ST1), all the teachers acknowledged that current students' attitude to and enjoyment of science was not particularly high. They thought that students did not see the relevance of what they were being taught, or enjoy how they were being taught. Teacher ST1, coming from a school that offered a science program for academically gifted students, recognised that her students were not typical with their positive attitude and strong application to science subjects. She thought that students in the school, generally, were more likely to reflect the norm.

All the teachers agreed that, if the decline in student numbers taking science subjects beyond the compulsory education years was to be reversed, changes needed to be made in the training of teachers from the beginning. Primary school teachers needed to be given the skills to teach the subject well and confidently so that enthusiasm would be started at a young age. Science teaching in the High School years needed to be relevant, interesting, challenging but achievable, and teachers needed the skills to deliver that.

Whilst there was a difference in how boys and girls learn science, all the teachers were of the opinion that there wasn't a difference in attitude between the sexes. At the Primary level, any differences in attitude between the school years were seen as a reflection of the confidence and competence of the classroom teacher. Differences at the older level were considered dependent on whether the students had realised that there was a need for science in their career.

All agreed that teacher actions or inactions would affect the students' attitude to any subject, not just science. Students needed to feel able to ask questions without criticism and receive the help that they needed to progress. It was not appropriate behaviour for a teacher to favour the more successful students, or those who displayed a positive attitude to science.

6.3 Conclusions

The study confirmed the reliability of this modified form of the WIHIC when used in year 8, 9 and 10 science classes in Australia. The reliability of the Attitude to Science scale was also confirmed for this context.

The study has reported the relationship between the perceptions of junior high school students in relation to teacher support and equity in the classroom, and attitude to science classes. The findings have supported those of other studies (Aldridge, Fraser, & Fisher, 2003; Dorman, Fisher, & Waldrip, 2006; Fisher, Goh, & Rickards, 1996; Fisher & Rickards, 1996; Khine & Fisher, 2001; Kim, Fisher, & Fraser, 2000; Koul & Fisher, 2006; Wubbels, 1993;) showing that the impact of both teacher support and equity on attitude is positive and statistically significant. The more the students perceive the teachers to display these behaviours, the more favourable their attitude to science. Of the two factors, teacher support explains more of the variance in attitude than equity.

The importance of the learning environment and its impact on attitude to science cannot be overstated. The present study and all the others reviewed have shown that there is a statistically significant relationship between the learning environment scales measured on instruments such as the WIHIC and attitude to the school subject area. The relationship is also a positive one, clearly showing that as the students' perception of the teacher behaviours increase, so does their attitude to science.

By focussing on teacher support and equity in the classroom and their relationship to attitude to science classes, the results of this study are likely to have implications for teacher practice by relating specific teacher actions to student attitudes. Making teachers aware of the benefits of consciously demonstrating basic classroom etiquette, such as giving support to the students and treating them all equitably, could be a simple, cost effective way of lifting the profile of science. Imparting information may not be enough. The environment that it is given in, and the manner in which it is given, however, could make all the difference to the students. The suggestion from the teachers who were interviewed that this sort of training is not given during their learning process is of concern. The pre-service teacher, in particular, could not recall receiving instruction on appropriate behaviour that the teacher should demonstrate in the classroom. The emphasis had been on the management of student behaviour rather than management of the teacher's behaviour. During subsequent conversations (not recorded), comments were made by two of the interviewed teachers that taking part in this study had made them think about the level of support and equitable treatment they gave to their students and how it could be improved. Whilst there was no before and after data available for these two particular teachers, the study by Saunders and Fisher (2006) showed that informing teachers about their role in the learning environment, thus giving them the opportunity to make changes to their behaviours (teaching practice), did impact positively on the students' perceptions.

The 2003 study by Waldrip and Fisher into the characteristics of science teachers showed that teachers identified as exemplary were those that scored highly in the teaching practice areas of being friendly, helping a lot, and communicating well with the students. These practices correspond to the questions in the Helping/Friendly scale of the QTI and the Teacher Support scale of the WIHIC that have subsequently been shown to impact on students' attitude. To be identified as good or exemplary, according to the perceptions of the students, must also provide a boost to the teachers themselves. Indeed the teachers who were interviewed considered communication skills to be one of the attributes of an ideal science teacher. They also thought that the students themselves would describe their ideal teacher as one who was approachable, friendly, open, and who listens. The comment was also made that students have preconceived ideas about what they expect of their teachers, and if those expectations are not met, disenchantment and disengagement with the subject area may follow.

The Dorman and Ferguson (2004) study suggested that the likely disengagement with the subject can also have an impact on the students' self perception in the form of self-handicapping. They found that as students' perceptions of their learning environment become more positive their apparent need for self-handicapping decreased. The results of self-handicapping are most obvious during assessment and whilst the classroom environment has been found to influence attitude, Dorman, Fisher, and Waldrip (2006) concluded that assessment is such an integral part of that environment that it also contributes to students' attitude.

6.4 Limitations of the Study

The main limitations of this study have been the amount of data collected, both quantitative and qualitative, and the statistical analysis methods chosen.

The student questionnaire was only administered in the Australian Capital Territory, Queensland, and Western Australia and whilst the final sample size was large (N=1,775), responses from other states and territories would have given a more complete picture for Australia. Also, as already stated, using a convenience sample of one pre-service teacher and three teachers cannot be presumed to be representative of teachers generally. The questions they were asked were initially designed to inform the researcher on aspects of an unfamiliar setting but subsequently provided information that confirmed the findings from the students' perception data.

A mixed method approach to the student data could also have provided valuable insights into the students' perceptions. Whilst use of perception data collected by questionnaire is justified, using a 4-point response scale and relatively few items in each scale, could have resulted in the loss of variability of responses. Collection of qualitative information from the students may have helped confirm the statistical findings or, indeed, contradict them.

The statistical methods chosen to analyse the quantitative data were appropriate to address the research questions but a more in-depth approach through multiple regression or structural equation modelling may have revealed other important associations between the variables. Also the student questionnaire only allowed gender and year group comparisons but other studies have shown the impact of the students' sociometric status (Parish & Fisher, 2006) and cultural background and gender of the teacher (Khine & Fisher, 2001) on students' perceptions.

No information was collected in regard to the actual content of teacher training courses beyond that recalled by the four interviewees so direct statements about any lack of appropriate teaching practice information may be misguided.

6.5 Implications

Fielding (2006) concluded that the teachers were the most important part of the entire education system since the environment that they created had a direct impact on the students in their care. All teachers need to be made aware of that impact and the potential effect it has. It should be an integral part of teacher training and a part of ongoing professional development for current teachers.

The effect of improved teacher support to and equitable treatment of students will have multiple effects:

1. students will perceive their teachers to be closer to their ideal and therefore view them more favourably;
2. the teachers' actions could be described as good or exemplary, providing a boost to morale in a difficult profession and thus improving their self-confidence;
3. students' self-perceptions will improve creating more self-confidence for them and a more positive perception of the classroom;
4. attitude to science will improve which, in turn, increases the chance of ongoing study; and
5. the study of science will benefit the community as it will ensure developments that will make life better for all

The process of change should start with the training of Primary School teachers. Providing them with sufficient training in the delivery of science content will increase their confidence and ability once they get to the classroom. This in turn will foster a genuine interest in the subject area that will be carried forward to High School. Whilst it may be essential for students to learn the underlying scientific principles, an approach needs to be identified that shows the relevance of that learning and demonstrates it in an engaging way for the students but this will take time. In the shorter term, making teachers aware of the importance of various teaching practices such as support and equity, will help to lift the profile and impact on the students' attitude.

Given that there is a need for students to have a more favourable attitude to science if they are to continue studying it in post-compulsory education, this positive association has a valuable practical and educational significance for teachers. An increase in the simple interpersonal actions of the teacher going out of their way to help the student; considering the students' feelings; talking with the students; being interested in students' problems; treating all students equitably, and moving about the class to talk to the students should bring about a more positive attitude.

Just as science teaching and learning seems to be at crisis point in the formal education arena, training and developing competencies in the non-formal/voluntary situation is also at a critical level. It might well be that training of the leaders in that sector needs to include interpersonal skill development as well as knowledge development to help bring about change.

6.6 Summary

The declining numbers of students choosing to study science beyond the compulsory school years is of concern to both governments and educationalists. Science and scientists are not only important to the economic future of Australia but the skills learned during the study of the discipline are important to other subjects and to life generally. Whilst the students' attitude to science may be, in part, a product of the way the subject is taught, it is also significantly affected by the behaviours of the teachers within the learning environment.

Attitude to science has been consistently shown to be positively and significantly associated with the perceived amount of teacher support received by the students, and the receipt of equitable treatment in the classroom. The first two years of high school (Years 8 and 9) are when attitudes to science as a study area, and as a possible career, are formed (Speering & Rennie, 1996). The present study has shown that those are also the years when attitude to science is at its lowest level. Given that an increase in teacher support and equitable treatment results in a more positive attitude to science, the simple process of raising teachers' awareness of these two behaviours could have a far reaching and long lasting impact on the future prosperity of Australia.

REFERENCES

Abraham, W. (1982). Teaching. In *The World Book Encyclopedia* (Vol. 19, pp. 55-58a). Chicago: World Book Inc.

Aldridge, J.M., & Fraser, B.J. (1997). Examining science classroom environments in a cross-national study. Retrieved June 10, 2005, from http://education.curtin.edu.au/waier/forums/1997/aldridge.html

Aldridge, J., Fraser, B., & Fisher, D. (2003, January). *Investigating student outcomes in an outcomes based, technology-rich learning environment*. Paper presented at the Third International Conference on Science, Mathematics and Technology Education, East London, South Africa.

Allen, D., & Fraser, B.J. (2002, April). *Parent and student perceptions of the classroom learning environment and its influence on student outcomes*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, USA.

Australian Council of the Deans of Science (2004). *Policy Framework.* Retrieved March 11, 2006, from http://www.acds.edu.au/members/ACDS_policy_2004.htm

Baker, D. (1997). Equity issues in science education. In B. Fraser & K. Tobin (Eds), *International Handbook of Science Education* (pp.869-896). Dordrecht, The Netherlands: Kluwer.

Bishop, J. (2006, August 10). [Address]. Address presented to the National Press Club of Australia. [Transcript]. Retrieved August 31, 2006 from http://www.dest.gov.au/Ministers/Media/Bishop/2006/08/b0041008.6.asp

Bransford, J.D., Brown, A.L., & Cocking, R. (Ed.). (1999). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press. Retrieved March 11, 2006, from http://newton.nap.edu/html/howpeople1/notice.html

Buck, G.A. (2001). Teaching discourses: Science teachers' responses to the voice of adolescent girls. *Learning Environments Research: An International Journal, 5*, 29-50.

Cavanagh, R.F., & Waugh, R.F. (2004). Secondary school renewal: The effect of classroom learning culture on educational outcomes. *Learning Environments Research, 7*, 245-269.

Créton, H., Hermans, J., & Wubbels, Th.. (1990). Improving interpersonal teacher behaviour in the classroom: A systems communication perspective. *South Pacific Journal of Teacher Education*, 18, 85-94.

Dorman, J. (2002). Classroom environment research: Progress and possibilities. *Queensland Journal of Educational Research, 18*(2), 112-140. Retrieved January 5, 2006 from http://education.curtin.edu.au/iier/qjer/qjer18/dorman.html

Dorman, J.P., & Ferguson, J.M. (2004). Associations between students' perceptions of mathematics classroom environment and self-handicapping in Australian and Canadian high schools. *McGill Journal of Education Montreal*: *39*(1), 69-86.

Dorman, J., Fisher, D., & Waldrip, B. (2006). Classroom environment, students' perceptions of assessment, academic efficacy and attitude to science: A LISREL analysis. In D. L. Fisher & M. S. Khine (Eds), *Contemporary approaches to research on learning environments: World views* (pp. 1-28). Singapore: World Scientific.

Education. (1982). In *The World Book Dictionary* (p. 670). Chicago, USA: World Book, Inc.

Ferguson, P.D., & Fraser, B.J. (1999). Changes in learning environment during the transition from primary to secondary school. *Learning Environments Research, 1*, 369-383.

Field, A. (2005). *Discovering statistics using SPSS*. London: Sage Publications Ltd.

Fielding, J. (2006). Discovering and capturing the heart of teaching: Is that what effective teaching is all about? In D.L. Fisher, D. Zandvliet, I. Gaynor & R. Koul (Eds), *Proceedings from the Fourth International Conference on Science, Mathematics and Technology Education. Victoria, Canada*.

Fisher, D.L., & Fraser, B.J. (1981). Validity and use of My Class Inventory. *Science Education*, 65, 145-156.

Fisher, D., & Fraser, D. (1983). A comparison of actual and preferred classroom Environment as perceived by science teachers and students. *Journal of Research in Science Teaching, 20* (1), 55-61.

Fisher, D.L., Goh, S.C., & Rickards, T.W.J. (1996, November). *Perceptions of interpersonal teacher behaviour in secondary science classroom*. Paper presented at the Conference of the Educational Research Association, Singapore. Retrieved February 22nd, 2005, from http://www.aare.edu.au/96pap/gohsc96474.txt

Fisher, D., & Rickards, A. (1996). Association between teacher-student interpersonal behaviour and student attitudes in mathematics classes. *Proceedings Western Australian Institute for Educational Research Forum 1996*. Retrieved June 4th, 2005, from http://www.education.curtin.edu.au/waier/forums/1996/fisher.html

Fisher, D.L., & Waldrip, B.G. (1999). Cultural factors of science classroom learning environments, teacher-student interactions and student outcomes. *Journal of Science Education and Technology, 17*(1), 83-96.

Fraser, B.J., (1981). *Test of Science-Related Attitudes handbook (TOSRA).* Melbourne, Australia: Australian Council for Educational Research.

Fraser, B.J. (1998). Classroom environment instruments: Development, validity and applications. *Learning Environments Research, 1* (1), 7-33.

Fraser, B.J. (2001). Twenty thousand hours: Editor's introduction. *Learning Environments Research, 4*, 1-5.

Fraser, B.J. (2002). Learning environments research: Yesterday, today and tomorrow. In S.C. Goh and M.S. Khine (Eds.), *Studies in educational learning environments: An international perspective* (pp. 1-25). Singapore: World Scientific Publishing.

Fraser, B.J., & Fisher, D. (1983a). Use of actual and preferred classroom environment scales in person-environment fit research. *Journal of Educational Psychology, 75*, 303-313.

Fraser, B.J., & Fisher, D.L. (1983b). Student achievement as a function of person-environment fit: A regression surface analysis. *British Journal of Educational Psychology, 53*, 89-99.

Fraser, B.J. & Tobin, K.G. (Eds). (1998). Qualitative and quantitative landscapes of classroom learning environments. *International Handbook of Science Education* (pp. 623-640). UK: Kluwer Academic Publishers.

Fraser, B.J., Anderson, G.J. & Walberg, H.J. (1982). *Assessment of learning environments: Manual for learning environment inventory (LEI) and my class inventory (MCI)* (3^{rd} ed.). Western Australian Institute of Technology, Perth, Australia.

Fraser, B.J., Fisher, D.L., & McRobbie, C.J. (1996, April). *Development, validation and use of personal and class forms of a new environment instrument*. Paper presented at the annual meeting of the American Educational Research Association, New York, USA.

Fraser, B.J., McRobbie, C.J., & Giddings, G.J. (1993). Development and cross-national validation of a laboratory classroom environment instrument for senior high school sciences. *Science Education*, 77, 1-24.

Fraser, B.J., Treagust, D.F., & Dennis, N.C. (1986). Development of an instrument for assessing classroom psychosocial environments at universities and colleges. *Studies in Higher Education*, 11, 43-54.

Goh, S.C. & Fraser, B.J. (1998). Teacher interpersonal behaviour, classroom environment and student outcomes in primary mathematics in Singapore. *Learning Environments Research, I*, 199-229.

Goodrum, D., Hackling, M., & Rennie, L. (2001). *The status and quality of teaching and learning of science in Australian schools*. Department of Education, Training and Youth Affairs: Canberra.

Gough, A., Waldrip, B.G., Tytler, R., Beeson, G. & Sharpley, B. (2002, April). *Improving effective science teaching and learning in Australian schools*. A paper presented at the Annual Meeting of the National Association of Reasearch in Science Teaching, New Orleans.

Henderson, D.G., Fisher, D.L., & Fraser, B.J. (1998). *Learning environments, student attitudes and other effects of students' sex and other science study in environmental science classes.* Paper presented at the annual meeting of the American Educational Research Association (San Diago, CA).

Hunt, D.E. (1975). Person environment interaction: A challenge found wanting before it was tried. *Review of Educational Research, 45*, 209-230.

Khine, S.W. & Fisher, D.L. (2001). *Classroom environment and teachers' cultural background in secondary science classes in an Asian context*. Paper presented at the International Educational Research Conference (Fremantle, Australia). Retrieved May 27th, 2006, from http://www.aare.edu.au/01pap/khi01004.htm

Kim, H., Fisher, D., & Fraser, B. (2000). Classroom environment and teacher interpersonal behaviour in secondary science classes in Korea. *Evaluation and Research in Education, 14*, 3-22.

Klopfer, L.E. (Ed). (1992). A summary of research in science education – 1990. *Science Education, 76*(3), 239-338.

Koul, R.B., & Fisher, D. (2006). A contemporary study of learning environments in Jammu, India. In D. L. Fisher & M. S. Khine (Eds), *Contemporary approaches to research on learning environments: World views* (pp. 273-295). Singapore: World Scientific.

Lewin, K. (1936). *Principles of topological psychology* (F. Heider & G. M. Heider, Trans.). New York: McGraw-Hill.

Margianti, E.S. (2003). The relationship between attitudes and achievement of university students in computer classrooms in Indonesia. In M.S.Khine & D.Fisher (Eds). *Technology-rich learning environments: A future perspective* (71-96). Singapore: World Scientific.

Marlino, M.R. (1997). Science education, scientific literacy, and technology: Issues and promises (Abstract). Paper presented at ASCILITE '97, Perth, Australia. Retrieved March 11, 2006, from http://www.ascilite.org.au/conferences/perth97/papers/Marlino/Marlino.html

Moos, R.H. (1979). Evaluating educational environments. San Francisco, CA. Jossey-Bass, Inc.

Moos, R.H., & Trickett, E.J. (1987). Classroom environment scale manual (2nd ed.). Palo Alto, CA.: Consulting Psychologists Press.

Murcia, K. (2005, July). *Science for the 21st century: Teaching for scientific literacy in the primary classroom*. Paper presented at CONASTA 54, Melbourne, Australia.

Murray, H.A. (1938). *Explorations in personality*. New York: Oxford University Press.

Parish, P., & Fisher. D. (2006). An investigation of the relationship between student sociometric status and their perceptions of the classroom environment. In D.L. Fisher, D. Zandvliet, I. Gaynor & R. Koul (Eds), *Proceedings from the Fourth International Conference on Science, Mathematics and Technology Education*, (pp. 459-468). Victoria, Canada.

Parker, L., Rennie, L., & Fraser, B. (Eds). (1996*). Gender, science and mathematics: Shortening the shadow*. Dordrecht, The Netherlands: Kluwer.

Rentoul, A.J., & Fraser, B.J. (1979). Conceptualisation of enquiry-based or open classroom learning environments. *Journal of Curriculum Studies*, *11*. 233-245.

Rickards, T., den Brok, P., Bull, E., & Fisher, D. (2003). Predicting student views of the classroom: A Californian perspective. *Proceedings Western Australian Institute for Educational Research Forum 2003*. Retrieved June 10, 2005, from http://education.curtin.edu.au/waier/forums/2003/rickards-1.html

Rogoff, B. (2001, September 14). Student assessment for the information age. *The Chronicle of Higher Education, 48(*3), p. B17.

Saunders, K. & Fisher, D. (2006). An action research approach with primary pre-service teachers to improve university and primary school classroom environments. In D. Fisher & M. S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp.247-271). UK: Imperial College Press.

Schaffner, M., Burry-Stock, J.A., Cho, G., Boney, T., & Hamilton, G. (2000, April) *What do kids think about their teachers' grade?* Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA)

Scott, R. H. (2001). *Students' perceptions of science teachers' behaviour in Brunei Darussalam*. Unpublished doctoral dissertation, Curtin University of Technology, Perth, Western Australia.

Speering, W. & Rennie, L. (1996). Students' perceptions about science: The impact of transition from primary to secondary school. *Research in Science Education, 26* (3), 283-298.

SPSS Inc. (2005). SPSS for Windows (Version 14). Chicago.

Taylor, P.C., Dawson, V., & Fraser, B.J. (1995). *Classroom learning environments under transformation: A constructivist perspective*. Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA)

Tobin, K. & Fraser, B.J. (1998). Qualitative and quantitative landscapes of classroom learning environments. In B.J. Fraser and K.G. Tobin (Eds.), *International handbook of science education* (pp. 623-640). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Walberg, H.J. (1976). Psychology of learning environments: Behavioural, structural, or perceptual? *Review of Research in Education*, *4*, 142-178.

Walberg, H.J. & Anderson, G.J. (1968). Classroom climate and individual learning. *Journal of Educational Psychology*, 59, 414-419.

Waldrip, B.G. & Fisher, D.L. (2000, January). *Teacher-student interactions in primary science: validity and application of a questionnaire*. Paper presented at the Second International Conference on Science, Mathematics and Technological Education, Taiwan.

Waldrip, B.G. & Fisher, D.L. (2003). Identifying exemplary science teachers through their classroom interactions with students. *Learning Environments Research, 6*, 157-174.

Walker, S.L. (2001, April). *Online learning environments research*. Paper presented at the Sixth Annual Teaching in the Community Colleges Online Conference, Kapi'olani Community College, University of Hawaii. Retrieved May 27 2006 from http://kolea.kcc.hawaii.edu/tcc/tcon01/papers/walker.html

Walker, S.L. (2004). *Learning environment research: a review of the literature*. (Learning Environments Monograph No. 3). San Marcos, TX: Texas State University – San Marcos, geography Department. Retrieved May 28 2006 from http://uweb.txstate.edu/sw36/monographs

Wallace, J., Venville, G., & Chou, C. (2002). “Cooperate is when you don’t fight”: Students’ understandings of their classroom learning environment. *Learning Environments Research, 5*, 133-153.

Waxman, H.C. & Huang, S.L. (1998). Classroom learning environments in urban elementary, middle, and high schools.. *Learning Environments Research, 1*, 95-113.

Wubbels, T. (1993). *Teacher-student relationships in science and mathematics Classes*. (What Research Says, No. 11). Perth: Curtin University of Technology.

Zyngier, D. (2005). Choosing our ideas, words and actions carefully: Is the language of productive pedagogies intelligible for pre-service teachers? *Issues in Educational Research, 15 (2)*, 225-248.

APPENDIX A

STUDENT QUESTIONNAIRE

The completion of this questionnaire implies your informed consent to participate.

Student Questionnaire

This questionnaire asks you for your views about science assessment and about your perceptions of your class. Science assessment includes tests, assignments, projects and anything that your teacher uses to assess your learning. This is **NOT** a test. Your opinion is what is wanted.

The questionnaire has a number of sentences about you or your class. For each sentence, circle the letter or number corresponding to your response. For example:

	Almost never	Sometimes	Often	Almost always
I like to be told in advance when I am being assessed.	**AN**	**S**	**O**	**AA**

If you agree that you are told in advance when you are to be assessed, circle the **AA**. If you disagree and do not think that you are told in advance when you are to be assessed, circle the **AN**. You also can choose the letters **O**, and **S** that are in-between. If you want to change your answer, cross it out and circle a new one. Thank you for your cooperation.

School ________________________

1. Year Level

Year 8	☐	1
Year 9	☐	2
Year 10	☐	3

2. Are you a:

Female	☐	1
Male	☐	2

Students' Perceptions of Assessment (SPAQ)	Almost Never	Sometimes	Often	Almost Always
1. Questions my teacher asks me in science, tests what I know.	AN	S	O	AA
2. My science assignments/tests examine what I do in class.	AN	S	O	AA
3. My assignments/tests are about what I have done in class.	AN	S	O	AA
4. How I am assessed is like what I do in class.	AN	S	O	AA
5. How I am assessed is similar to what I do in class.	AN	S	O	AA
6. I am assessed on what the teacher has taught me.	AN	S	O	AA
7. I am asked to apply my learning to real life situations.	AN	S	O	AA
8. My science assessment tasks are useful in everyday things.	AN	S	O	AA
9. I find science assessment tasks are relevant to what I do outside of school.	AN	S	O	AA
10. Assessment in science tests my ability to apply what I know to real-life problems.	AN	S	O	AA
11. I find science assessment tasks are relevant to what I do outside of school.	AN	S	O	AA
12. I can show others that my learning has helped me do things.	AN	S	O	AA
13. In science I am asked about the types of assessment that are used.	AN	S	O	AA
14. I am aware how my assessment will be marked.	AN	S	O	AA
15. I can select how I will be assessed in science.	AN	S	O	AA
16. I have helped the class develop rules for assessment in science.	AN	S	O	AA
17. My teacher has explained to me how each type of assessment is to be used.	AN	S	O	AA
18. I have a say in how I will be assessed in science.	AN	S	O	AA
19. I understand what is needed in all science assessment tasks.	AN	S	O	AA
20. I know what is needed to successfully complete a science assessment task.	AN	S	O	AA
21. I am told in advance when I am being assessed.	AN	S	O	AA
22. I am told in advance on what I am being assessed.	AN	S	O	AA
23. I am clear about what my teacher wants in my assessment tasks.	AN	S	O	AA
24. I know how a particular assessment task will be marked.	AN	S	O	AA

	Almost Never	Sometimes	Often	Almost Always
25. I have as much chance as any other student at completing assessment task.	AN	S	O	AA
26. I complete assessment tasks at my own speed.	AN	S	O	AA
27. I am given a choice of assessment tasks.	AN	S	O	AA
28. I am given assessment tasks that suit my ability.	AN	S	O	AA
29. When I am confused about how to complete an assessment task, I am given another way to answer it.	AN	S	O	AA
30. When there are different ways, I can choose the way I like to complete the assessment.	AN	S	O	AA

This section asks you for your opinion about your science class

Learning Environment	Almost Never	Sometimes	Often	Almost Always
1. I make friendships among students in this science class.	AN	S	O	AA
2. I am friendly to members of this science class.	AN	S	O	AA
3. Members of this science class are my friends.	AN	S	O	AA
4. I work well with other science class members.	AN	S	O	AA
5. Students in this science class like me.	AN	S	O	AA
6. The teacher goes out of his/her way to help me.	AN	S	O	AA
7. The teacher considers my feelings.	AN	S	O	AA
8. The teacher talks with me.	AN	S	O	AA
9. The teacher is interested in my problems.	AN	S	O	AA
10. The teacher moves about the class to talk with me.	AN	S	O	AA
11. I discuss ideas in science class.	AN	S	O	AA
12. I give my opinions during class discussions.	AN	S	O	AA
13. My ideas and suggestions are used during classroom discussions.	AN	S	O	AA
14. I ask the teacher questions.	AN	S	O	AA
15. I explain my ideas to other students.	AN	S	O	AA

		Almost Never	Sometimes	Often	Almost Always
16.	Getting a certain amount of work done is important to me.	AN	S	O	AA
17.	I know what I am trying to accomplish in this class.	AN	S	O	AA
18.	I pay attention during this science class.	AN	S	O	AA
19.	I try to understand the work in this science class.	AN	S	O	AA
20.	I know how much work I have to do.	AN	S	O	AA
21.	The teacher gives as much attention to my questions as to other students' questions.	AN	S	O	AA
22.	I get the same amount of help from the teacher as do other students.	AN	S	O	AA
23.	I am treated the same as other students in this class.	AN	S	O	AA
24.	I receive the same encouragement from the teacher as other students do.	AN	S	O	AA
25.	I get the same opportunity to contribute to science class discussions as other students.	AN	S	O	AA

This final section asks to what extent that you agree with each statement

Student Attitudes		Disagree			Agree
1.	I look forward to science lessons.	1	2	3	4
2.	Science lessons are fun.	1	2	3	4
3.	I enjoy the activities we do in science.	1	2	3	4
4.	What we do in science are among the most interesting things we do in class.	1	2	3	4
5.	Finding out about new things is important.	1	2	3	4
6.	I enjoy science lessons in this class.	1	2	3	4
7.	We should spend more time on science each week.	1	2	3	4
8.	I feel pleased with myself with what I learn in science.	1	2	3	4
9.	I'm certain that I can master the skills taught in science this year.	1	2	3	4
10.	I can do even the hardest work in this science class if I try	1	2	3	4
11.	If I have enough time, I can do a good job on all my science class work.	1	2	3	4
12.	I can do almost all the science work if I don't give up.	1	2	3	4
13.	Even if the science is hard, I can learn it.	1	2	3	4
14.	I'm certain I can figure out how to do the most difficult science works.	1	2	3	4

APPENDIX B

PARENTAL CONSENT LETTER AND FORM

PARENT FORM
To Whom It May Concern
STUDENT INTERVIEW FORM

Researcher responsible for project: Associate Professor Bruce Waldrip, phone 07 4631 2338

USQ HREC No: H03STU327

Education Queensland Approval No**: 550/27/176**

Associate Professor Bruce Waldrip, University of Southern Queensland, Jeff Dorman, Australian Catholic University, in association with Professor Darrell Fisher, Curtin University (Western Australia) are conducting an Australian Government funded study to investigate how students' perceptions of assessment affect their attitudes and they way that they interact with their teachers.

The project will involve three stages, each stage lasting about a year.

In the **first year (2004**), an instrument to measure students' perceptions of assessment was developed. Some students were interviewed about their perceptions of assessment.

In the **second year (2005**), schools are asked to administer an instrument that measures students' perceptions of the assessment task, their perceptions of the classroom learning environment and their attitudes towards science. From these results, exemplary classrooms will be identified and approached for involvement in the next stage in 2006.

In the **third year (2006**), an in-depth study of teachers and their classrooms, as identified in the previous year, will involve classroom observations and teacher and student interviews, with the aim of enhancing description of exemplary middle school science teaching. Some students will be interviewed to help establish a picture of what happens in exemplary classrooms.

If selected for an interview, they are expected to be short and should not exceed 30 minutes. If you are chosen for the case study phase, your consent will be sought before implementation of that phase. You will not be identified in any published material.

If you have any questions regarding this project, please contact Associate Professor Waldrip in the first instance on telephone number 07 4631 2338. Please contact University of Southern Queensland's Research & Higher Degrees Office (tel 07 4631 2690) should there be any concerns about the nature and/or conduct of this research project. This study has the approval of Education Queensland.

If you agree to participate in this study, please sign the attached form.

Thank you for your cooperation.

Associate Professor Bruce Waldrip

Improving assessment in science through the use of students' perceptions

Researcher responsible for project: Associate Professor Bruce Waldrip, phone 07 4631 2338

USQ HREC No: H03STU327

Education Queensland Approval No: **550/27/176**

STUDENT AND PARENT FORM

CONSENT ON BEHALF OF A MINOR OR DEPENDENT PERSON

I,…………………………………….of ……………………………………

Hereby give consent

to be a subject of a human research study to be undertaken by Associate Professor Bruce Waldrip, Faculty of Education, University of Southern Queensland and Professor Darrell Fisher, Curtin University

and I understand that the purpose of the research is to examine how students' perceptions of assessment effect their attitudes and interactions with their teacher.

I acknowledge that:

1. the aims, methods, and anticipated benefits, and possible hazards/risks of the research study, have been explained to me.
2. I voluntarily and freely give my consent to participation in such research study.
3. aggregated results will be used for research purposes and may be reported in academic and educational journals.
4. Individual results **will not** be released to any person.
5. I am free to withdraw my consent at any time, during the study, in which event my participation in the research study will immediately cease and any information obtained will not be used.

Signature: Date:

<u>NOTE:</u> The parent or parents, or person(s) having guardianship of the child must sign the consent form.

APPENDIX C

SPSS SYNTAX FILE

```
if year=1 and sex=1 yrsex = 1.
if year=1 and sex=2 yrsex = 2.
if year=2 and sex=1 yrsex = 3.
if year=2 and sex=2 yrsex = 4.
if year=3 and sex=1 yrsex = 5.
if year=3 and sex=2 yrsex = 6.
value labels yrsex 1 'Year 8 Females' 2 'Year 8 Males' 3 'Year 9 Females'
        4 'Year 9 Males' 5 'Year 10 Females' 6 'Year 10 Males'.
variable labels yrsex 'Gender and School year combinations'.
execute.


frequencies variables= state year sex.

frequencies variables=a1 to a30 / statistics=mean stddev.

frequencies variables=b1 to b25 / statistics= mean stddev.

frequencies variables= at1 to at7 / statistics=mean stddev.

frequencies variables=ef8 to ef14 / statistics=mean stddev.


* Custom Tables.
CTABLES
  /VLABELS VARIABLES=sex state year DISPLAY=NONE
 /TABLE state > year BY sex [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1,
        TOTALS[COUNT 'N' F40.0]]
  /CATEGORIES VARIABLES=sex year ORDER=A KEY=VALUE EMPTY=INCLUDE
        TOTAL=YES POSITION=AFTER
  /CATEGORIES VARIABLES=state ORDER=A KEY=VALUE EMPTY=INCLUDE.


******** Overall factor analysis for 3 sections of questionnaire ***********.

FACTOR
        /VARIABLES a1 to a30
        /MISSING LISTWISE
        /ANALYSIS a1 to a30
        /PRINT INITIAL KMO EXTRACTION ROTATION
        /FORMAT SORT BLANK(.4)
        /CRITERIA MINEIGEN(1) ITERATE(25)
        /EXTRACTION PC
        /CRITERIA ITERATE(25)
        /ROTATION VARIMAX
        /METHOD=CORRELATION .

FACTOR
        /VARIABLES b1 to b25
        /MISSING LISTWISE
        /ANALYSIS b1 to b25
        /PRINT INITIAL KMO EXTRACTION ROTATION
        /FORMAT sorted BLANK(.4)
        /CRITERIA MINEIGEN(1) ITERATE(25)
        /EXTRACTION PC
```

```
        /CRITERIA ITERATE(25)
        /ROTATION VARIMAX
        /METHOD=CORRELATION .

FACTOR
        /VARIABLES at1 to ef14
        /MISSING LISTWISE
        /ANALYSIS at1 to ef14
        /PRINT INITIAL KMO EXTRACTION ROTATION
        /FORMAT SORT BLANK(.4)
        /CRITERIA MINEIGEN(1) ITERATE(25)
        /EXTRACTION PC
        /CRITERIA ITERATE(25)
        /ROTATION VARIMAX
        /METHOD=CORRELATION .

***** Reliabilities for Assessment scales *********.

RELIABILITY
        /VARIABLES=a1 to a6
        /FORMAT=NOLABELS
        /SCALE(ALPHA)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=a7 to a12
        /FORMAT=NOLABELS
        /SCALE(ALPHA)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=a13 to a18
        /FORMAT=NOLABELS
        /SCALE(ALPHA)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=a19 to a24
        /FORMAT=NOLABELS
        /SCALE(ALPHA)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=a25 to a30
        /FORMAT=NOLABELS
        /SCALE(ALPHA)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .
```

```
********** Create Learning Environment subscales *************.

compute cohesiveness = mean(b1 to b5).
compute support = mean(b6 to b10).
compute involvement = mean(b11 to b15).
compute orientation = mean(b16 to b20).
compute equity = mean(b21 to b25).
compute attitude =mean(at1 to at7).
compute efficacy = mean (ef8 to ef14).
variable labels cohesiveness 'Student Cohesiveness in this Class'
        support 'Teacher Support in this Class'
        involvement 'Involvement in this Class'
        orientation 'Task Orientation in this Class'
        equity 'Equity in this Class'
        attitude 'Student Attitudes to Science Class'
        efficacy 'Academic Efficacy to Science'
.
execute.

descriptives variables=cohesiveness to efficacy.

*********Teacher support subscale ********.

* Custom Tables.
CTABLES
  /VLABELS VARIABLES=b6 b7 b8 b9 b10 DISPLAY=DEFAULT
  /TABLE
    b6 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
        STDDEV F40.2]]
 + b7 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
        STDDEV F40.2]]
 + b8 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
        STDDEV F40.2]]
 + b9 [COUNT 'N'  F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
        STDDEV F40.2]]
 + b10 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
        STDDEV F40.2]]
  /CLABELS ROWLABELS=OPPOSITE
  /CATEGORIES VARIABLES=b6 b7 b8 b9 b10 ORDER=A
   KEY=VALUE EMPTY=INCLUDE TOTAL=YES POSITION=AFTER.

RELIABILITY
        /VARIABLES=b6 to b10
        /FORMAT=NOLABELS
        /SCALE(Support)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

means tables=support by year by sex.

EXAMINE
        VARIABLES=support BY sex year
        /PLOT BOXPLOT NPPLOT
        /COMPARE GROUP
        /STATISTICS DESCRIPTIVES
        /CINTERVAL 95
        /MISSING LISTWISE
        /NOTOTAL.
```

```
IGRAPH /VIEWNAME='Boxplot'
	/X1 = VAR(value_set1) TYPE = CATEGORICAL
	/Y = VAR(support) TYPE = SCALE  /COLOR =  VAR(category_set1)
		TYPE = CATEGORICAL /COORDINATE = VERTICAL
	/COMBINE  GROUP=VAR(category_set1) TYPE=CATEGORICAL 'Category'
		 RESPONSE=VAR(value_set1)
		TYPE=CATEGORICAL 'Value' VAR(sex) 'Gender' VAR(year) 'School Year'
	/X1LENGTH=4.5 /YLENGTH=3.0
	/X2LENGTH=3.0 /CHARTLOOK='NONE'
	/CATORDER VAR(category_set1) (ASCENDING VALUES OMITEMPTY)
	/CATORDER VAR(value_set1)  (ASCENDING VALUES OMITEMPTY)
	/BOX OUTLIERS = ON EXTREME = ON MEDIAN = ON WHISKER = T.
EXE.

t-test groups=sex(1,2)/variables=support.

NPAR TESTS
	/M-W= support   BY sex(1 2)
	/MISSING ANALYSIS.

ONEWAY
	support  BY year
	/STATISTICS DESCRIPTIVES HOMOGENEITY
	/PLOT MEANS
	/MISSING ANALYSIS
	/POSTHOC = SCHEFFE BONFERRONI ALPHA(.05).

NPAR TESTS
	/K-W=support   BY year(1 3)
	/MISSING ANALYSIS.

UNIANOVA
	support  BY year sex
	/METHOD = SSTYPE(3)
	/INTERCEPT = INCLUDE
	/EMMEANS = TABLES(year*sex)
	/PRINT = DESCRIPTIVE HOMOGENEITY
	/CRITERIA = ALPHA(.05)
	/DESIGN = year sex year*sex .

GRAPH
	/LINE(MULTIPLE)MEAN(support) BY year BY sex .

ONEWAY
	support  BY yrsex
	/STATISTICS DESCRIPTIVES HOMOGENEITY
	/PLOT MEANS
	/MISSING ANALYSIS
	/POSTHOC = SCHEFFE BONFERRONI ALPHA(.05).

NPAR TESTS
	/K-W=support   BY yrsex(1 6)
	/MISSING ANALYSIS.

IGRAPH /VIEWNAME='Boxplot' /X1 = VAR(yrsex) TYPE = CATEGORICAL
	/Y = VAR(support) TYPE = SCALE
	/COORDINATE = VERTICAL
	/X1LENGTH=4.0 /YLENGTH=3.0 /X2LENGTH=3.0 /CHARTLOOK='NONE'
	/CATORDER VAR(yrsex) (ASCENDING VALUES OMITEMPTY)
	/BOX OUTLIERS =  ON EXTREME = ON MEDIAN = ON WHISKER = T.
```

```
EXE.

*********Equity subscale ********.

* Custom Tables.
CTABLES
  /VLABELS VARIABLES=b21 b22 b23 b24 b25 DISPLAY=DEFAULT
  /TABLE
    b21 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
          STDDEV F40.2]]
 + b22 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
          STDDEV F40.2]]
 + b23 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
          STDDEV F40.2]]
 + b24 [COUNT 'N'  F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
          STDDEV F40.2]]
 + b25 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
          STDDEV F40.2]]
  /CLABELS ROWLABELS=OPPOSITE
  /CATEGORIES VARIABLES=b21 b22 b23 b24 b25 ORDER=A
   KEY=VALUE EMPTY=INCLUDE TOTAL=YES POSITION=AFTER.

RELIABILITY
          /VARIABLES=b21 to b25
          /FORMAT=NOLABELS
          /SCALE(equity   )=ALL
          /MODEL=ALPHA
          /STATISTICS=SCALE
          /SUMMARY=TOTAL .

means tables=equity   by year by sex.

EXAMINE
          VARIABLES=equity   BY sex year
          /PLOT BOXPLOT NPPLOT
          /COMPARE GROUP
          /STATISTICS DESCRIPTIVES
          /CINTERVAL 95
          /MISSING LISTWISE
          /NOTOTAL.

IGRAPH /VIEWNAME='Boxplot'
          /X1 = VAR(value_set1) TYPE = CATEGORICAL
          /Y = VAR(equity   ) TYPE = SCALE  /COLOR =  VAR(category_set1)
                    TYPE = CATEGORICAL /COORDINATE = VERTICAL
          /COMBINE  GROUP=VAR(category_set1) TYPE=CATEGORICAL 'Category'
                     RESPONSE=VAR(value_set1)
                    TYPE=CATEGORICAL 'Value' VAR(sex) 'Gender' VAR(year) 'School Year'
          /X1LENGTH=4.5 /YLENGTH=3.0
          /X2LENGTH=3.0 /CHARTLOOK='NONE'
          /CATORDER VAR(category_set1) (ASCENDING VALUES OMITEMPTY)
          /CATORDER VAR(value_set1)  (ASCENDING VALUES OMITEMPTY)
          /BOX OUTLIERS = ON EXTREME = ON MEDIAN = ON WHISKER = T.
EXE.

t-test groups=sex(1,2)/variables=equity   .

NPAR TESTS
          /M-W= equity   BY sex(1 2)
          /MISSING ANALYSIS.
```

```
ONEWAY
      equity  BY year
      /STATISTICS DESCRIPTIVES HOMOGENEITY
      /PLOT MEANS
      /MISSING ANALYSIS
      /POSTHOC = SCHEFFE BONFERRONI ALPHA(.05).

NPAR TESTS
      /K-W=equity   BY year(1 3)
      /MISSING ANALYSIS.

UNIANOVA
      equity  BY year sex
      /METHOD = SSTYPE(3)
      /INTERCEPT = INCLUDE
      /EMMEANS = TABLES(year*sex)
      /PRINT = DESCRIPTIVE HOMOGENEITY
      /CRITERIA = ALPHA(.05)
      /DESIGN = year sex year*sex .

GRAPH
      /LINE(MULTIPLE)MEAN(equity) BY year BY sex .

ONEWAY
      equity  BY yrsex
      /STATISTICS DESCRIPTIVES HOMOGENEITY
      /PLOT MEANS
      /MISSING ANALYSIS
      /POSTHOC = SCHEFFE BONFERRONI ALPHA(.05).

NPAR TESTS
      /K-W=equity   BY yrsex(1 6)
      /MISSING ANALYSIS.

IGRAPH /VIEWNAME='Boxplot' /X1 = VAR(yrsex) TYPE = CATEGORICAL
      /Y = VAR(equity) TYPE = SCALE
      /COORDINATE = VERTICAL
      /X1LENGTH=4.5 /YLENGTH=3.0 /X2LENGTH=3.0 /CHARTLOOK='NONE'
      /CATORDER VAR(yrsex) (ASCENDING VALUES OMITEMPTY)
      /BOX OUTLIERS =  off EXTREME = ON MEDIAN = ON WHISKER = T.
EXE.

********* Attitude subscale ********.

* Custom Tables.
CTABLES
  /VLABELS VARIABLES=at1 to at7 DISPLAY=DEFAULT
  /TABLE
    at1 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
      STDDEV F40.2]]
 + at2 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
      STDDEV F40.2]]
 + at3 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
      STDDEV F40.2]]
 + at4 [COUNT 'N'  F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
      STDDEV F40.2]]
 + at5 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
      STDDEV F40.2]]
 + at6 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
```

```
          STDDEV F40.2]]
 + at7 [COUNT 'N' F40.0, ROWPCT.COUNT '%' PAREN40.1, TOTALS[MEAN F40.2,
          STDDEV F40.2]]
  /CLABELS ROWLABELS=OPPOSITE
  /CATEGORIES VARIABLES=at1 at2 at3 at4 at5 at6 at7 ORDER=A
   KEY=VALUE EMPTY=INCLUDE TOTAL=YES POSITION=AFTER.

RELIABILITY
          /VARIABLES=at1 to at7
          /FORMAT=NOLABELS
          /SCALE(Attitude)=ALL
          /MODEL=ALPHA
          /STATISTICS=SCALE
          /SUMMARY=TOTAL .

means tables=attitude by year by sex.

EXAMINE
          VARIABLES=attitude BY sex year
          /PLOT BOXPLOT NPPLOT
          /COMPARE GROUP
          /STATISTICS DESCRIPTIVES
          /CINTERVAL 95
          /MISSING LISTWISE
          /NOTOTAL.

IGRAPH /VIEWNAME='Boxplot'
          /X1 = VAR(value_set1) TYPE = CATEGORICAL
          /Y = VAR(attitude) TYPE = SCALE  /COLOR =  VAR(category_set1)
                    TYPE = CATEGORICAL /COORDINATE = VERTICAL
          /COMBINE  GROUP=VAR(category_set1) TYPE=CATEGORICAL 'Category'
                     RESPONSE=VAR(value_set1)
                    TYPE=CATEGORICAL 'Value' VAR(sex) 'Gender' VAR(year) 'School Year'
          /X1LENGTH=4.5 /YLENGTH=3.0
          /X2LENGTH=3.0 /CHARTLOOK='NONE'
          /CATORDER VAR(category_set1) (ASCENDING VALUES OMITEMPTY)
          /CATORDER VAR(value_set1)  (ASCENDING VALUES OMITEMPTY)
          /BOX OUTLIERS = ON EXTREME = ON MEDIAN = ON WHISKER = T.
EXE.

t-test groups=sex(1,2)/variables=attitude.

NPAR TESTS
          /M-W= attitude   BY sex(1 2)
          /MISSING ANALYSIS.

ONEWAY
          attitude  BY year
          /STATISTICS DESCRIPTIVES HOMOGENEITY
          /PLOT MEANS
          /MISSING ANALYSIS
          /POSTHOC = SCHEFFE BONFERRONI ALPHA(.05).

NPAR TESTS
          /K-W=attitude   BY year(1 3)
          /MISSING ANALYSIS.

UNIANOVA
          attitude  BY year sex
          /METHOD = SSTYPE(3)
```

```
        /INTERCEPT = INCLUDE
        /EMMEANS = TABLES(year*sex)
        /PRINT = DESCRIPTIVE HOMOGENEITY
        /CRITERIA = ALPHA(.05)
        /DESIGN = year sex year*sex .

GRAPH
        /LINE(MULTIPLE)MEAN(attitude) BY year BY sex .

ONEWAY
        attitude  BY yrsex
        /STATISTICS DESCRIPTIVES HOMOGENEITY
        /PLOT MEANS
        /MISSING ANALYSIS
        /POSTHOC = SCHEFFE BONFERRONI ALPHA(.05).

NPAR TESTS
        /K-W=attitude   BY yrsex(1 6)
        /MISSING ANALYSIS.

IGRAPH /VIEWNAME='Boxplot' /X1 = VAR(yrsex) TYPE = CATEGORICAL
        /Y = VAR(attitude) TYPE = SCALE
        /COORDINATE = VERTICAL
        /X1LENGTH=4.5 /YLENGTH=3.0 /X2LENGTH=3.0 /CHARTLOOK='NONE'
        /CATORDER VAR(yrsex) (ASCENDING VALUES OMITEMPTY)
        /BOX OUTLIERS =  ON EXTREME = ON MEDIAN = ON WHISKER = T.
EXE.

*********** Support, equity, attitude relationships ************.

correlations variables=support equity attitude.

nonpar corr variables=support equity attitude.

IGRAPH /VIEWNAME='Boxplot'
        /X1 = VAR(category_set1) TYPE = CATEGORICAL
        /Y =  VAR(value_set1) TYPE = SCALE
        /COORDINATE = VERTICAL
        /COMBINE  GROUP=VAR(category_set1) TYPE=CATEGORICAL '  '
                RESPONSE=VAR(value_set1) TYPE=SCALE '  '
                VAR(support) 'Teacher Support in this Class'
                VAR(equity) 'Equity in this Class'
                VAR(attitude) 'Student Attitudes to Science Class'
        /X1LENGTH=4.5 /YLENGTH=3.0 /X2LENGTH=3.0
        /CHARTLOOK='NONE'
        /CATORDER VAR(category_set1) (ASCENDING VALUES OMITEMPTY)
        /BOX OUTLIERS = ON EXTREME = ON MEDIAN = ON WHISKER = T.
EXE.

REGRESSION
        /DESCRIPTIVES MEAN STDDEV CORR SIG N
        /MISSING MEANSUB
        /STATISTICS COEFF OUTS CI BCOV R ANOVA CHANGE
        /CRITERIA=PIN(.05) POUT(.10)
        /NOORIGIN
        /DEPENDENT attitude
        /METHOD=enter support
        /RESIDUALS NORM(ZRESID) .

REGRESSION
```

```
        /DESCRIPTIVES MEAN STDDEV CORR SIG N
        /MISSING MEANSUB
        /STATISTICS COEFF OUTS CI BCOV R ANOVA CHANGE
        /CRITERIA=PIN(.05) POUT(.10)
        /NOORIGIN
        /DEPENDENT attitude
        /METHOD=enter equity
        /RESIDUALS NORM(ZRESID) .

REGRESSION
        /DESCRIPTIVES MEAN STDDEV CORR SIG N
        /MISSING MEANSUB
        /STATISTICS COEFF OUTS CI BCOV R ANOVA CHANGE
        /CRITERIA=PIN(.05) POUT(.10)
        /NOORIGIN
        /DEPENDENT attitude
        /METHOD=enter support equity
        /RESIDUALS NORM(ZRESID) .

sort cases by sex.
split file by sex.
correlations variables=support equity attitude.
split file off.

sort cases by sex.
split file separate by sex.
REGRESSION
        /DESCRIPTIVES MEAN STDDEV CORR SIG N
        /MISSING MEANSUB
        /STATISTICS COEFF OUTS CI BCOV R ANOVA CHANGE
        /CRITERIA=PIN(.05) POUT(.10)
        /NOORIGIN
        /DEPENDENT attitude
        /METHOD=enter support equity
        /RESIDUALS NORM(ZRESID) .
split file off.

sort cases by year.
split file by year.
correlations variables=support equity attitude.
split file off.

sort cases by year.
split file separate by year.
REGRESSION
        /DESCRIPTIVES MEAN STDDEV CORR SIG N
        /MISSING MEANSUB
        /STATISTICS COEFF OUTS CI BCOV R ANOVA CHANGE
        /CRITERIA=PIN(.05) POUT(.10)
        /NOORIGIN
        /DEPENDENT attitude
        /METHOD=enter support equity
        /RESIDUALS NORM(ZRESID) .
split file off.

************ Other subscales *************.

FACTOR
        /VARIABLES at1 to at7
        /MISSING LISTWISE
```

```
        /ANALYSIS at1 to at7
        /PRINT INITIAL KMO EXTRACTION ROTATION
        /FORMAT SORT BLANK(.3)
        /CRITERIA MINEIGEN(1) ITERATE(25)
        /EXTRACTION PC
        /CRITERIA ITERATE(25)
        /ROTATION VARIMAX
        /METHOD=CORRELATION .

FACTOR
        /VARIABLES ef8 to ef14
        /MISSING LISTWISE
        /ANALYSIS ef8 to ef14
        /PRINT INITIAL KMO EXTRACTION ROTATION
        /FORMAT SORT BLANK(.3)
        /CRITERIA MINEIGEN(1) ITERATE(25)
        /EXTRACTION PC
        /CRITERIA ITERATE(25)
        /ROTATION VARIMAX
        /METHOD=CORRELATION .

RELIABILITY
        /VARIABLES=b1 to b5
        /FORMAT=NOLABELS
        /SCALE(Cohesiveness)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=b11 to b15
        /FORMAT=NOLABELS
        /SCALE(involvement)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=b16 to b20
        /FORMAT=NOLABELS
        /SCALE(Task_orientation)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=at1 to at7
        /FORMAT=NOLABELS
        /SCALE(attitude)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .

RELIABILITY
        /VARIABLES=ef8 to ef14
        /FORMAT=NOLABELS
        /SCALE(efficacy)=ALL
        /MODEL=ALPHA
        /STATISTICS=SCALE
        /SUMMARY=TOTAL .
```

```
EXAMINE
            VARIABLES=cohesiveness to efficacy
           /COMPARE VARIABLE/PLOT=BOXPLOT
           /STATISTICS=NONE/NOTOTAL
           /MISSING=PAIRWISE .

EXAMINE
           VARIABLES=cohesiveness to efficacy
           /PLOT BOXPLOT HISTOGRAM NPPLOT
           /COMPARE GROUP
           /STATISTICS DESCRIPTIVES
           /CINTERVAL 95
           /MISSING PAIRWISE
           /NOTOTAL.

****************** Summary ***************.


IGRAPH /VIEWNAME='Line Chart' /X1 = VAR(yrsex) TYPE = CATEGORICAL
           /Y =  VAR(value_set1) TYPE = SCALE
            /STYLE = VAR(category_set1) /COORDINATE =  VERTICAL
            /COMBINE  GROUP=VAR(category_set1)
                       TYPE=CATEGORICAL 'Category'  RESPONSE=VAR(value_set1)
                       TYPE=SCALE 'Value'
                       VAR(attitude) 'Student Attitude to Science Class'
                       VAR(equity) 'Equity in this Class'
                       VAR(support) 'Teacher Support in this Class'
             /X1LENGTH=4.5 /YLENGTH=3.0 /X2LENGTH=3.0
            /CHARTLOOK='NONE' /CATORDER VAR(category_set1)
                       (ASCENDING VALUES OMITEMPTY)
           /CATORDER VAR(yrsex) (ASCENDING VALUES OMITEMPTY)
           /LINE(MEAN) KEY=ON STYLE = LINE DROPLINE = OFF
                       INTERPOLATE = STRAIGHT BREAK = MISSING.
EXE.
```