Science and Mathematics Education Centre

The Effect of Cooperative Group Work and Assessment on the Attitudes of Students towards Science in New Zealand

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ABSTRACT

The improvement of secondary-level students' attitude to science is encouraged in the New Zealand curriculum document. It is also noteworthy that employers in scientific institutions and commercial organisations place great value on group or teamwork. However, it is apparent that some teachers have reservations about cooperative group work, particularly problems with classroom management. There has been significant research done on cooperative learning and student attitudes, but investigations about the use of cooperative group work to improve the science-related attitudes of our younger secondary school students are rare.

This thesis focuses on the effect of cooperative group work and assessment on the attitudes of 312 science students in four rural secondary schools in New Zealand. The cooperative groups were established using a simplified protocol which was non intrusive on curriculum delivery to help ensure wide acceptance by secondary science teachers. The students' attitudes were assessed quantitatively using the *Test of Science Related Attitudes* (TOSRA) while qualitative results were obtained through teacher and student interviews along with researcher observations.. The data were collected before and after three terms of cooperative learning in a variety of activities including practical classes, fieldwork, and written assignments and class tests. This part of the study revealed that group work and group assessment enhanced students' attitudes to science, with both the teachers and students seeing real value in such activities, especially the formative group testing opportunities.

The study also confirmed the reliability and validity of the TOSRA in New Zealand schools for the first time. The TOSRA was also used to make comparisons of the science-related attitudes of several subgroups within the study population. Such comparisons included the effects of gender, grade level and band along with consideration of the roles of the teacher and classroom environment on student attitudes.

Finally, a teacher friendly set of guidelines for the implementation of cooperative group work and assessment in the classroom has been prepared as result of this ongoing research.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Research into cooperative group work and assessment in science is not new and is fully reviewed in Chapter 2. However, the ways in which group work and assessment can be linked to create an environment which students find both stimulating and rewarding forms the basis of this research.

While positive cognitive outcomes are very important for secondary school students as they progress through their college years, without positive attitudes towards their science subjects they are unlikely to pursue a science-related career or maintain a lifelong interest in science. In fact, many will often have negative attitudes towards the activities of scientists and science-related issues. If we wish people to be able to make informed and non-emotive decisions on many of the science-based issues likely to face society in the 21st Century then positive attitudes are important. In many countries, the promotion of favourable attitudes towards science is viewed as a central aim of science education (Fraser, 1981b; Kelly, 1986).

Many successful modern companies spend a lot of time, money, and effort in developing the 'team ethos'. Team-building activities are fundamental to their staff development programmes and are seen as invaluable. Over the past 20 years the number of providers of these activities has risen significantly. The employment officer of Grayson's Laboratories (personal communication, September, 1995) stated that the single-most important factor, when they consider employing staff, is the ability to work cooperatively in a team. Whereas there are some jobs that can be filled by individuals that prefer to work on their own, these are rare and often of a temporary nature and so the good team member is often the most prudent staff selection.

Wellins (1991) in his modern business book ‘Empowered Teams’ perhaps best summarises how effective teams can work in the following quote (p. 146):

> Effective teams are not just collections of people. Rather they comprise an entity that is greater than the sum of its parts. This means that team members

> must work together closely and make every effort to cooperate and support one another.

Similarly, the Charter of the East Waikato Science Fair, New Zealand (described in section 1.2) includes the following aim: 'To foster the ability among students to work cooperatively to achieve a common goal'. It is very likely then that the development of good teamwork and positive attitudes in science are both important and necessary as far as employers and students are concerned.

Kroll, Masinglia, and Mau (1992) observed that we should use evaluation procedures that match the instructional format that is used and hence if students frequently work in small groups then they should be assessed in those small groups.

Gilbert (1990) observed that activities in which students manipulate ideas and materials themselves lead to deeper processing of ideas. There is a need to find viable and practical alternatives to the passive activity of listening to the teacher and answering short factual questions.

Both of these viewpoints lead to the conclusion that educationalists should be doing more group work and group assessment in our secondary schools. As far as testing is concerned, Murray (1990) recommended alternative methods such as allowing group discussion prior to testing could be the subject of further research. Similarly, Atkins (1993) recommended that current assessment methods should be changed to include increased emphasis on the assessment of small group work. Thus, there is a need for more research in this area.

In the *Science in the New Zealand Curriculum* document (Ministry of Education, 1993) it was suggested (in the section on enhancing achievement) that learning is enhanced when (p. 10): 'Students have the opportunity to clarify their ideas, to share and compare, question, evaluate, and modify these ideas, leading to scientific understanding'.

This document further stated that the primary purpose of school-based assessment is to improve students' learning and the quality of learning programmes.

Assessment tasks and procedures should be consistent with the general aims of science education and be compatible with regular classroom activity. In this way, assessment will be an integral part of the learning programme. This in many ways supports the need for more group assessment as a follow up to students' cooperative group work in the classroom. This thesis responds to these new directions by examining the effects of both group work and assessment on the attitudes and motivation of students in science in New Zealand.

1.2 THE CURRENT SITUATION IN NEW ZEALAND

In most New Zealand schools, Year 9 and 10 science students (Year 9 students in New Zealand are typically 13 years of age on entry) are taught primarily as individuals but with some cooperative group work often included to ease resource management. Laboratory work is usually undertaken in cooperative group situations of two, three or four students. Usually this is done in order to promote cooperative work and to manage laboratory resources. Group work is also used in fieldwork and other tasks involving data collection. Sharing of the work throughout the group is actively encouraged, although as this is not usually assessed because there tend to be 'doers' and 'watchers' in many of the groups.

The following section contains a summary of the main types of activities found in New Zealand schools at Year 9 and 10 together with the types of assessment normally employed for each activity.

1.2.1 Research Projects

There are two main types of open-ended research activities usually undertaken in New Zealand schools. These are the Science Fair and CREST programmes.

Science Fair

Students try to solve problems, which they find of interest to them, usually by experiment. They are encouraged to use valid research methods. The results are presented on display boards along with logbooks and any other relevant material. Most schools have a school-based fair from which the best projects are selected to go to a regional fair. The best project from these is sent on to the New Zealand Fair (there are 30 finalists from throughout New Zealand). The best few national exhibits often get trips overseas to display their work internationally. Students are able to work in pairs or as individuals.

Judges using set descriptors usually make the assessment but marks are not usually given. Some schools, however, do assign marks for these projects, often on a five-point scale, using aspects such as scientific content and communication and investigative skills. A typical report using this achievement based assessment can be seen in Appendix A.

CREST

Creativity in Science and Technology (CREST), like the Science Fair, represents an opportunity for students to undertake research within a framework of assistance. At secondary school there are three levels of achievement - bronze, silver, and gold - with increasing rigor at each level. At the silver and gold levels, external assessors and consultants are appointed, usually university or industry based. For example, the University of Waikato and the National Institute of Water and Atmospheric Research are both involved in running the Waikato branch of the awards. The gold awards are very prestigious, with only a few such awards made nationally each year. Any student who perseveres with their project can achieve bronze awards. CREST has been managed in New Zealand by Massey University and the New Zealand Science Teachers' Association and originates from the United Kingdom. The Royal Society of New Zealand currently manages CREST.

CREST work can be undertaken in pairs or as individuals although there is provision for 'Team CREST' where groups of up to five or six can work together.

The assessor, with increasing rigor at each level, carries out the assessment of CREST. It is essentially pass/fail but students are able to re-present and may be helped to pass so long as they persevere. At gold level an oral presentation is made to a group of scientists, usually a mix of postgraduates and lecturers with an interest in the project.

1.2.2 Laboratory Work and Practical Exams

Students' practical work is usually assessed on an individual basis, whether it is a collated report of an experiment actually completed by a group of students or an individual practical exam or test where a range of practical skills is tested. These tests are often set up in the station-type structure with students moving from one activity to another after a given time. Normally, experiments are simple three to five minute exercises on a range of topics, for example, wiring a circuit and obtaining a reading from a meter. Typically some form of data processing will be included in associated one- to two-hour practical exams.

Some schools are trying new methods of assessment of practical work. One typical example is TAPS, as follows.

Techniques for the Assessment of Practical Skills (TAPS) (1981-1991), which originated in Scotland, is having some effect in New Zealand schools. This is a much more rigorous approach than the two methods described above and three levels of practical skills can be tested. These levels are listed in Table 1.1.

Table 1.1
Techniques for the Assessment of Practical Skills (TAPS)

Level One	Basic skill areas; observational, recording, measurement, manipulative, procedural and following instructions.
Level Two	Process skills: inference and selection of procedures
Level Three	Investigative skills: generative, experimentation, evaluation, recording and reporting

1.2.3 Written Research Projects

These are the types of projects that are based on a literature search usually in the school library or based on the Internet. They are typically undertaken in either pairs or as individuals and presented as a folder, a written report, or in the case of pairs or groups, as a poster. Some schools require students to produce a computer-based report. Some schools require an oral presentation and some include the use of programmes such as 'PowerPoint'.

Assessment of these projects does vary but is often carried out on an individual basis even though the data may have been collected in pairs or groups.

1.2.4 Written Tests and Examinations

These are carried out by individuals and marked as such. There has been a trial over recent years of different methods for assessing student scripts. However, most of these 'new' methods are simply attempts to vary from norm-referenced assessment.

<u>Overview of Assessment in Science</u>

The use of both individual and cooperative group practical work is becoming more common while the assessment method varies from individual to group assessment. The latter is much more common when the work is presented as a poster, a group presentation or in a format where contributions of individuals cannot be accurately measured. In many cases, group projects are consequently incompletely assessed. Teachers sometimes see this as a flaw in the assessment process and as a result students do not always see these assessments as important because they do not get a significant mark for their efforts. It is of interest to note that Osborne and Freyberg (1985) claimed that the teaching style preferred by most teachers involves large amounts of teacher input. This is followed by student activity and practice, and then more teacher input often in the form of feedback and evaluation. Such a preference is possibly the reason why teachers are at times reluctant to use group assessment.

Individuals throughout the year sit the majority of tests formally. Tests are usually of about one hour duration and follow the end of each unit of work. There are usually eight to ten units in a course with a major exam at the end of the year also assessed on an individual basis.

The *Science in the New Zealand Curriculum* (Ministry of Education, 1993) document does encourage much more varied assessment methods than has been the case in the past. Such methods include reports, investigations, interviews with key people, experimental designs (including fair testing), and ability to work cooperatively in groups. Most of these methods involve individuals working as a cooperative group, but many schools still assess the individual's work rather than the collated report arising from his/her group.

Essentially, group assessment has low status in New Zealand secondary schools at this time.

1.3 AIM

The aim and objectives of this thesis have arisen out from my observations of student attitudes over the course of my teaching career in science and the need to make science more achievable and relevant to the students. The central aim was to determine the effect of cooperative group work and assessment on the attitudes and motivation of students towards science in New Zealand. My research set out to gauge the effects of the following on the motivation and attitudes towards science of Year 9 and 10 students.

- Minimising the impact of perceived difficult aspects of science by making the students feel more secure during classwork and the often traumatic assessment procedures carried out in many New Zealand schools.

- Encouraging students to work cooperatively towards achieving a common goal, whether the goal is an assignment, laboratory or fieldwork or an assessed exercise.

- Encouraging students to enjoy their science while still achieving to their full potential.

The establishment of small cooperative groups in which the students carry out all of the preliminary work and any assessments could possibly achieve this. All members of the group will receive the same mark for any given assessment exercise and students will be encouraged to communicate and work cooperatively during these activities (such as assignments, tests, laboratory work and field work). The aspect of enjoyment while working within a team is promoted.

The measurement of student attitudes is fully outlined in Chapter 3. The methods proposed include observations by the researcher, interviews with both teachers and students, and the use of a quantitative instrument, the *Test of Science Related Attitudes* (TOSRA) (Fraser 1981a). The TOSRA contains seven distinct scales: Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. Each of these scales is suitable for group administration during the course of a normal lesson. Although TOSRA has been carefully developed and extensively field tested in Australia and has been shown to be highly reliable, it has not yet been used much in New Zealand. Therefore, an additional objective of this study will be to determine the reliability and validity of the TOSRA for use in New Zealand. Evaluations using TOSRA will be undertaken both before the students embark on their science programme and later as selected science units are completed.

1.4 OBJECTIVES

The objectives of the study were:

1. to provide validation data for the use of the *Test of Science Related Attitudes* (TOSRA) in New Zealand;

2. to determine relationships of grade and gender of students with their attitudes to science; and

3. to determine the effect of a cooperative approach to learning and assessment on the attitudes of students to science.

1.5 SIGNIFICANCE OF THE STUDY

This study focused on the effect that group work in both classroom activities and assessment tasks had on the attitudes towards science of Year 9 and 10 students. While group activities are not new, the use of teamwork during assessment tasks was a significant variation from the norm.

Some significant contributions also were made to the study of group work and attitudes. Firstly, the instrument used to study attitudes towards science (TOSRA) was validated for the first time with a large sample in New Zealand, and this finding should encourage further research into attitudes towards science in this country.

Secondly, qualitative methods, such as interviews and videotaping were applied to students in order to establish any changes in attitudes towards science. These methods represent an attempt to get students to say exactly what they felt about their science programmes. The third significant contribution this study made was an in-depth look at the effect gender had on students' attitudes towards science.

The fourth and perhaps most significant contribution of the study was the ongoing involvement and testing by the researcher in order to establish a teacher-friendly set of guidelines for the implementation of cooperative group work and assessment in the classroom. Such guidelines, supported by the other research findings, are clearly very useful to classroom teachers.

1.6 OVERVIEW OF THESIS

This chapter has provided the background to the study, aims, objectives, and significance of the study. Chapter 2 provides a review of the literature and shows that although there has been some excellent work on cooperative learning there have been very few studies which tie together cooperative group work, assessment and student attitudes.

The methodology used in this study is outlined in Chapter 3. It includes a description of how the schools and classes, which constituted the sample for the research, were selected. Guidelines on the setting up the groups within their classes and how they were expected to work together during various activities including a range of assessment tasks are described. Details of how the early pilot study was conducted are included. There is an outline of how quantitative and qualitative data were collected about students' attitudes. The *Test of Science Related Attitudes* (TOSRA) was the instrument used to collect the quantitative data, and observations, student and teacher interviews along with video tapes were used to collect qualitative data.

In Chapter 4 the focus is on the validity of the TOSRA. This was the first time the TOSRA had been used in a significant number of schools in New Zealand, and descriptive statistics were used to validate its application.

Relationships between grade, gender, and attitudes towards science are discussed in Chapter 5 by exploring the sub-populations of the sample of students in the study. The significance of these relationships is discussed at the end of the chapter.

The main objective of the study is addressed in Chapter 6, namely the effect of the cooperative group work and assessment on the attitudes of students towards science.

The quantitative data collected by TOSRA during the course of the study are fully analysed and discussed. The qualitative data from the taped interviews and observations are analysed and conclusions are drawn. A summary of the chapter gives a comprehensive overview of the results integrating all of the data.

Finally, Chapter 7 provides a broad overview of the findings of the thesis and discusses any limitations. The chapter then looks at recommendations and teaching practices that the classroom teacher can use to implement the recommendations. These practices include modifications to the classroom environment as a result of further trials undertaken since completion of the main study. This section is intended to be user friendly to the teachers who wish to pursue an active cooperative learning programme at Year 9 and 10 in New Zealand secondary schools.

CHAPTER 2

LITERATURE REVIEW

2.1 CHAPTER OVERVIEW

This chapter comprises a review of the history of relevant studies in cooperative group work, and of attitudes and gender found in the science education literature. The primary focus of this review is on the research objectives of the study outlined in Chapter 1 (p. 9). The work of some of the major contributors in recent times is summarised and in many cases significant features of many of their findings are used to establish the methodology for this study found in Chapter 3.

The first section of this chapter looks at how cooperative group based work has developed over time, and how recent researchers have contributed to our understanding of how to get optimal work from students in group-work situations. There are variations in the way cooperative groups can be established and operated in different studies but there are some underlying fundamentals that are carried through into the establishing the best methodology.

The second section looks at attitudes, initially from a historical perspective and then with the development of an understanding of attitudes as viewed today. Several studies consider the effect of gender, age and background on the resulting attitudes towards science. The ongoing development of instruments designed to quantify science-related attitudes is tracked along with the significant findings pertaining to the subsequent use of these instruments both by the developer and other researchers.

Researchers have found that some significant changes in attitudes towards science occur between Year 6 and Year 10. The age, gender, in school and out of school experiences of the students all appear to contribute to these changes. Relevant studies have been documented in the third section in order to establish what factors may influence student attitudes.

The conclusion outlines the unique nature of this study in that it combines many of the key elements found in the literature to ascertain the effect of cooperative group work on the science related attitudes of young students.

2.2 COOPERATIVE GROUP WORK

2.2.1 Early Research

Cooperative learning has been recognized as an effective learning tool for a very long time, even as long ago as the reign of the Babylonian Talmudin times BC. In the first century BC, the Roman philosopher Seneca Quintillion advocated cooperative learning with statements such as 'Qui Docet Discet' which means, 'When you teach you learn twice'. Johann Amos Comenius (Komensky) (1592-1670) was a theologian and educationalist from Czechoslovakia and Poland. He was considered very modern at the time in his thinking and believed that students would benefit by being taught and teaching other students. In the late 1700s the Reverend Dr. Andrew Bell (1753-1832) (Bell, 2001) pioneered cooperative work while teaching in Madras, India (Bell, 2001). While this was forced upon the teaching profession through teacher shortage, the idea of basically older students (called 'monitors') cooperatively teaching younger ones was a great success. On his return to England he encouraged schools to adopt 'the Madras System'. By the time of his death in 1832, some 10,000 schools were using his method. At the same time Joseph Lancaster forced by a shortage of teachers, was developing a similar system of 'monitors' (Lancaster, 2001). Lancaster was funded to travel to America to set up 'monitorial schools' in New York and Philadelphia.

Also during the eighteenth century, the University of Glasgow's professor of logic and philosophy, George Jardine, used 'peer review' to assist the skill development of his students in preparation for the entry into the world of work. To achieve this, Jardine had to teach communication skills. In the late 1800s, Colonel Francis Parker (1832-1902) was a strong advocate of cooperative learning. His 'Quincy method' was actually the releasing of the old fashioned bonds that restrained both the teacher and the child. It was Colonel Parker's intent to make the school a place of happiness and exploration (Gaillett, 1994, Brown & Thomson, 2000).

John Dewey (1922, 1924) used cooperative learning groups and student committees to ‘harness the powers’ of students to solve problems (Johnson, Johnson, & Holubec, 1994a). In his twin papers on cooperation and competition, Deutsh (1949a, 1994b) concluded that there would be more productivity from a group where the members were cooperative rather than competitive.

Following this, the ‘modern’ era of research into cooperative group work can be considered to start with the initial work by Johnson and Johnson at the University of Minnesota in the mid-1960s. Many investigations into cooperative group work have been undertaken since then. Such investigations have many components in common but often are subtly different in style.

2.2.2 The Modern Era

Many modern researchers share common ideas and goals for their cooperative learning strategies. Their research is tailored to investigate the effect of their particular environmental set-up on these ideas. The developmentally appropriate academic skills and better interpersonal skills are often the main focus of research. The competitive structure of most classrooms is seen as excellent for the winners, who become well-motivated students with high status (Ames & Ames, 1984), but in order to have winners you must have losers who become low-status students. These students often become resentful and may often use attention-seeking ploys to cover their low status.

The following section outlines the work of some key researchers in the modern era.

William Glasser

William Glasser (1969, 1986) suggests in his books, such as *Schools Without Failure* and *Control Theory in the Classroom* a slightly different approach to the other researchers. He approaches the problem by trying to address the large number of failures in high schools.

> Unless you have your head in the sand, you cannot fail to agree that about half of the secondary students in your regular classes make no consistent

> effort to learn. In fact if you take a close look at the young people in your greater family, you will see that close to half of them are firmly entrenched in this no effort group. (Glasser, 1986, p. 8)

Glasser (1986) is very critical of the contemporary education system. He states that to address the problems of this 'failure group' requires great effort and huge cost. He says that most schools exhibit an unnecessary proliferation of administrators, counselors, psychologists, special educators and reading specialists. He was also critical of so-called alternative schools. This second tier 'safety net' (of alternative schools) usually involves classes of no more than five or six students. Glasser maintains that even these low numbers are unhelpful to learning by the majority of students, and Glasser maintains that the failures continue to fill prison and welfare rolls and drug rehabilitation centres.

Glasser (1986) maintains that the traditional stimulus-response (s-r) theory on which most schools, and society in general, base human learning is in fact badly flawed. This theory maintains that people or events around us motivate what we do. These do things to us or for us and we act accordingly. People tend to believe that a reward or a punishment, threat or hurt can force us to behave differently. Rewards and punishments are still used as basic control techniques.

<u>Control Theory</u>

Glasser's (1986) 'control theory' is 'all about payoff' (p. 10). When students and teachers get more satisfaction from more immediate payoff they will perform better than otherwise. According to Glasser, the control theory of behavior is that 'we always choose to do what is most satisfying to us at the time' (p. 19). That is the personal satisfaction of the basic needs of all higher animals: (1) to survive and reproduce, (2) to belong, (3) to gain power, (4) to be free, and (5) to have fun. He emphasises the fun aspect of education and that many people remember how much fun they had learning from their best teachers and are often able to recall what they were taught in spite of perhaps having little need for what they learnt.

Learning Teams

Glasser (1986) states that 'in a control theory learning–team school, where the teacher is less of a lecturer and more of a facilitator-manager, there would be few major discipline problems' (p. 56). This is because in learning teams, where the students gain immediate satisfaction, it makes no sense to disrupt. With the teacher helping student teams to realize that there are better ways to handle frustration than choosing anger, any students who are temporarily frustrated can in fact be helped. Glasser also comments on the relevance of the material students are taught. Teaching can be more 'empowering' to the students if they can relate to such material.

> Unlike a sports team where better players are respected and admired by lesser players, classroom achievers are much more likely to be resented than accepted for their academic success. What they gain in power they lose in friendship (Glasser 1986, p. 70).

This philosophy is the basis for the formation of Glasser's so-called learning teams. According to Glasser (1986), there are eight basic reasons that learning teams will succeed in motivating most students:

1. Students gain a sense of belonging by working in teams of two to five. The teams should be selected by the teacher and comprise students with a range of abilities.
2. Belonging is the initial motivation for students to work and as they achieve success those who had not achieved previously sense that knowledge is power and will want to work.
3. Stronger students find it satisfying to help weaker ones because of the power and friendship associated with a high-performing team.
4. Weaker students find it satisfying because every little effort helps the team cause. When they worked alone, a little effort received no reward.
5. Students have less dependence on the teacher. They are encouraged to depend more on themselves, their own creativity and on other team members. Such a level of interdependence gives the students both power and freedom.

6. Learning teams provide a structure that helps the pupils get past the superficiality that plagues our schools today. Without this structure, there is less chance for students to learn enough in depth knowledge to make the important ‘knowledge is power’ connection.
7. The teams are free to decide how to convince the teacher, other students and parents that they have learned the material. Teachers encourage teams to offer evidence (other than tests) that the material has been learned.
8. The teacher is to ensure that all students have a chance of being in a high scoring team and will change teams on a regular basis. High performing teams tend to follow high-achieving students. This creates incentive regardless of any team strength.

Glasser considers that one of the most difficult tasks for teachers trying to learn to manage learning-teams, or even consider trying them, is to understand the difference between a *modern manager,* who is willing to share power and always on the lookout for better ways to do this, and a *traditional manager,* who never willingly gives up power and is always looking for more.

Robert Slavin

Robert Slavin and his co-workers developed STL (Student Team Learning) methods at the John Hopkins University. Slavin shares the view of other researchers that students’ peers often drive the change in attitudes from primary school to secondary school. Slavin (1995, p. 3) stated that:

> As students enter adolescence, the peer group becomes all-important, and most students accept their peers’ belief that doing more than is needed to get by is for suckers. Research clearly shows that academic success is not what gets students accepted by their peers, especially in junior high school.

He goes on to comment about the problems of low achievers. ‘After a while, they learn that academic success is not within their grasp, so they choose other avenues in which they may develop a positive self image. Many of these other avenues lead to anti social, delinquent behavior’ (Slavin, 1995, p. 4).

Slavin was instrumental in developing STL methods, some of which were based on the work by DeVries and Edwards (1973), also at Hopkins University. There are three main concepts central to all STL methods (Slavin, 1995), as follows:

1. Individual accountability. This essentially means that the success of the team depends on individual learning by all team members. Team members are encouraged to ensure that they help one another learn and that every team member is ready for any quiz or assessment that he or she may take without teammate help.
2. There are equal opportunities for success. Students of varying abilities, high, average and low achievers, are all encouraged to improve on their own past performances by setting their own goals. All contributions to the overall team effort are valued regardless of the size or importance.
3. Team rewards. Teams are able to gain rewards without necessarily competing for them. Provided that they achieve the set criteria, all, some or none of the teams can gain the reward.

Team rewards and incentives are still a controversial issue. Johnson and Johnson (1989) suggest a cautious use of incentives. Meloth and Deering (1994) have shown that setting the right conditions for cooperative learning can be just as effective as rewards.

Slavin (1983a; 1983b; 1989) maintained that just getting students to work together is not enough and that they must have a good reason to take one another seriously. His research showed that rewards and individual accountability are essential elements of any effective cooperative learning programme.

Slavin (1995) developed five main STL methods. Three of these methods are of a general nature and suitable for use in most subjects and levels. The remaining two are more subject- and grade-specific.

<u>Student Teams – Achievement Division (STAD)</u>

Students are assigned to four- or five-member teams mixed in performance level, gender, and ethnicity. The teacher presents a lesson on which the students then work in their teams. The students try to ensure that all team members have mastered the lesson and they then take the test or quiz as individuals without any outside help. The students' scores are then compared to their own previous test result averages and points are then awarded on the basis of how much the students have exceeded their previous scores. These points are then awarded as the team score. The procedure usually takes between three and five periods, for the presentation, team practice, and the test.

The main thrust of STAD is to motivate students to help each other master the skill presented to them by the teacher. They are encouraged to work together comparing answers to problems, quizzing each other in preparation for the final quiz or test. STAD has been used in a huge range of subjects at all levels. It is most appropriate for topics with well-defined objectives, such as science concepts and mathematical computations and applications.

Teams-Games-Tournament (TGT)

This was one of the first cooperative learning methods used at John Hopkins University and was developed originally by DeVries and Edwards (1973). It is similar to STAD but quizzes or tests are replaced by weekly tournaments where academic games are played and points are accumulated for their team score. Test results are used to match students for the next test. Successful students must face a student of higher ability next time. This process of 'bumping' helps ensure equal opportunities for success. The extra dimension of excitement adds to the fun of this work while individual accountability is retained.

Jigsaw II

The Jigsaw technique was originally developed by Aronson, Stephen, Blaney, Sikes and Snapp (1978) and has been adapted by Slavin into Jigsaw II. Here the same Learning Team structure as in STAD and TGT is retained. Individual students are assigned a topic of a unit and are then asked to study it in detail and become an expert. The experts on each of these common topics from all of the teams then meet and discuss their topic. They then return to their own teams and teach the topic to their teammates. Finally there is a quiz or test on the total unit including all of the individual topics learned. Scoring is the same as for STAD. Some units of work lend themselves more to this than others. The unit needs to be easily sub-divided into separate topics ensuring an even amount of work for each team member.

The remaining Learning Team methods are subject and grade specific. They are:

1. Cooperative Integrated Reading and Composition (CIRC) used in junior reading and writing.
2. Team Accelerated Instruction, which is used in junior mathematics.

Spencer Kagan

Spencer Kagan, the director of Cooperative Learning in California, devised and developed a structural approach to cooperative learning. Kagan's approach has similar concepts and basic beliefs to the Johnson and Johnson model (see below) and teachers are able to quite freely integrate the two approaches. In his more recent work, Kagan (1998) refered to 'new cooperative learning' where teachers are encouraged to use simple cooperative structures and strategies to convert existing lessons into cooperative ones. This approach is more likely to be readily accepted than having to devise specific cooperative lessons.

New Zealand researchers Brown and Thomson, both at Victoria University of Wellington, New Zealand, noted that Kagan's approach fits well with the nature of New Zealand teachers. They saw New Zealand teachers as being creative and active, and prepared to try a range of structures. Brown and Thomson (2000) have observed the extremely innovative way in which they are able to apply Kagan's structure to their regular classroom activities.

Kagan (1992, 1994) maintains that there are six key concepts. Not all cooperative lessons will use all of them but teachers need to have confidence in all of them if they are to successfully implement cooperative learning as envisaged by Kagan.

<u>Six Key Concepts</u>

1. Teams

Kagan maintains that there is a clear distinction between a group and a cooperative learning team. A group can vary in size and does not endure or have much of an identity while a team will endure and have a strong positive identity. Kagan maintains that four is the ideal number of team members as this allows for subdivision into two pairs, which is a bonus for some teamwork, whereas having more team members makes it harder to keep them all on task. Teams can be formed by a number of methods such as friendships or interests, and randomly formed by a draw. Teacher assignment to teams is seen as having a number of benefits such as a guaranteed heterogeneous group, which is seen as important by some researchers.

2. Cooperative Management

Management of the cooperative learning classroom varies a little from that of a regular classroom. Most of these variations involve issues such as ideal seating of the teams where all team members can access one another. Noise control and ways to ensure that all team members are on task are a few of the common issues.

3. Will to Cooperate

There are three ways in which the 'will to cooperate' can be created or maintained: team-building, class-building and reward or suitable recognition structures. Kagan suggested that group grades can motivate students but some problems can occur. If the group grade is an average of individual grades then there may be some resentment towards low scoring students. When a group grade is used to report on an individual student Kagan sees this as unacceptable since other students have contributed to the grade.

4. Skill to Cooperate

These are seen as important and can be improved in a number of ways including modelling, defining, role-playing, observing, reinforcing, processing and specific social skill practice.

5. Basic Principles

According to Kagan there are four basic underlying principles:

Positive interdependence

All team members must contribute if they are to have success. When one team member gains they all gain.

Individual accountability

Each individual must be able to perform the task alone.

Equal participation

There is relatively equal participation from all team members.

Simultaneous interaction

Most of the team members are active at any one moment.

Kagan refers to these principles with the acronym PIES. The first two principles are synonymous with those in the Johnson approach. Teachers use these principles when deciding if a particular structure is suitable for cooperative work.

6. Structures

Structures are essentially how the cooperative lesson is taught and they are content free.

Kagan divides the teaching and learning process into three main parts as follows:

- A structure is a format for working
- Content is what you work on
- Activities are the result of structures and content brought together.

When combining the curriculum content with a learning activity provided, a teacher is able to follow Kagan's PIES principles. Kagan identifies six primary purposes for the structures as follows:

- Class building
- Team building
- Communication
- Information sharing
- Mastery
- Concept development/thinking skills

Kagan refer to these structures as 'domains of usefulness'.

David and Roger Johnson

Brothers David and Roger Johnson from the University of Minnesota are often viewed as modern day 'heavyweights' in the field of cooperative learning. Much of their recent work is modelled on their original work (Johnson, Johnson, Holubec, & Roy, 1984). Since then Johnson and Johnson have established a basic model for cooperative learning in the classroom. Johnson and Johnson (1987, 1989, 1991, 1994) established the basic idea of three-goal structures and suggested that there is no reason why these structures cannot be integrated into the same lesson. The goal structures are *competitive, individualistic and cooperative.* The following statement summarises feelings about students and these goal structures.

> We believe that all students should be able to compete for fun and enjoyment, work autonomously on their own, and cooperate effectively with others. Just as important, students should know when to compete, when to work on their own, when to cooperate. Johnson and Johnson (1999, p. x).

Johnson and Johnson (1999) go on to define these structured learning goals in a classroom context where these lessons are structured so that students:

1. engage in a win-lose struggle to see who is best in completing the assignment;
2. work independently to complete the assignment; and
3. work together in small groups, ensuring all members complete the assignment.

Structured learning goals can be thought of as a combination of the following:

- A learning goal is where mastery or competence in a particular subject area can be demonstrated.
- A goal structure is the way in which students interact to achieve their goals. They may have either no effect on the success or failure of others or a positive effect. The students essentially engage in competitive, individualistic or cooperative efforts.

Group Size

The size of the group may vary according to various factors, Johnson and Johnson (1999) use the acronym TEAM to help when deciding on the size of a team as follows:

T	Time limits
E	Students Experience in working in groups
A	Students' Age
M	Materials and equipment available

Johnson and Johnson maintained that as a basic rule smaller groups were better and that many teachers use groups of four, five or six before they have the skills to competently work in groups of this size. While there is no ideal size, a number between two and four is seen as sound for most beginning students.

Johnson and Johnson supported such small groups for most activities with the following comments:

- With additional members of a group the resources required to ensure success also increases.
- If there is a shorter time available this means that small groups are more efficient with each member getting more opportunity to contribute.
- There will be more accountability with small groups as there is less opportunity to 'hide'.
- With larger groups, other than sheer manageability of the increased number of possible interactions, there is usually less team unity and fewer friendships.
- Smaller groups are easier to monitor for any problems that may occur such as disputes and fair contributions by all group members

Assigning students to groups

Johnson and Johnson (1985, 1999) suggest a variety of ways of group selection all of which have some appeal to the classroom teacher as follows:

- Random assignment is the easiest teacher-organized method. This involves simply assigning all students a number, for example, 1 to 10 if there are to be 10 groups; those with the same numbers then form a group. A variation on this method is to group the students according to their interests such as a favourite sport; their common interests then form the basis of the groups.
- Random stratified assignment is where the entire class is ranked on some relevant unit test or pretest and then the groups are formed by firstly selecting

the top, lowest and middle students, then the next highest and lowest and middle until all of the students are assigned to a mixed ability group.

- Teacher selected groups involve the teacher organizing the groups in a way that he/she thinks is most suitable for all students. Johnson and Johnson have suggested that their favourite method is to select all of the non achievement-orientated students and assign each individual to two other supportive and caring students, which forms the basis of the group.
- Johnson and Johnson do not favour self-selected groupings, as they are often homogenous for ability, ethnic minority and gender, and which may result in more off-task behaviour. A suggestion, which may avert some of these problems, is for students to list the students they would like to work with and then they are grouped with one from their list plus one other.

<u>Cooperative groups versus other groups</u>

Johnson, Johnson and Holubec (1994b) identify the need for teachers to be aware of the features of a truly cooperative group and how this awareness can affect any learning or achievement outcomes of any group. The four main types of cooperative groups often found in regular classrooms have been identified as follows:

1. The Pseudo-Learning group: These students are grouped to work together but have no genuine interest to do so. They often believe that they will be ranked as individuals and hence have no interest in cooperation. They are in fact often undermining and distrusting one another and would perform better working as individuals.
2. The traditional classroom learning group: Students are grouped and realise that they need to work together but assignments are structured in such a way that little cooperative work is really required. They believe that they will be assessed and rewarded as individuals, so helping and sharing of each other's information is minimal. There are 'free riders' that want to exploit the more conscientious group members who subsequently feel less inclined to put in their usual effort and in fact would probably be better off working alone.
3. The cooperative learning group: Students are again grouped and are happy to work together. They appreciate that their group's success depends upon the

effort of all members. Johnson, Johnson and Holubec (1994b) suggest that there are five main features of such a group.

- They all realize that they can achieve better with a good combined effort than as individuals and that they 'sink or swim together, and if one fails they all fail' (p. 6)
- They all know that they have individual accountability for producing work of a high standard to realize their group's potential.
- They will work face-to-face producing good work together assisting one another to achieve through active encouragement, helping and sharing.
- They learn the appropriate skills, which enable them to reach their goals through appropriate teamwork and responsibility.
- They continually assess how they are progressing towards their goals through working together.

'As a result, the group is more than the sum of its parts, and all students perform better academically than they would if they had worked alone' (p. 7).

4. The high performance group: this group is outstanding and rare, easily achieving the standards of a full cooperative group but they have hugely increased commitment to one another and to the group's success. As a result they exceed expectations and enjoy themselves.

<u>Skills in Cooperative Group Work: - Assigning Roles</u>

Johnson and Johnson (1994) insisted that if groups are to perform to their potential then members must learn the essential skills of cooperative group work. Such skills may be achieved by assigning prescribed roles that group members can expect from one another and which will be expected of them.

There are four levels of group functioning and the roles of group members are changed to suit both the skills of the group and according to their age. The four levels of group functioning are *forming, functioning, formulating* and *fermenting*. The roles assigned include adding various monitors to ensure that the group carries the key elements of each level.

Forming: This is essentially to ensure that the group gets together and has the basic structures in place to ensure that it can function smoothly and productively. Key elements of this level and roles are:

- Groups move together quietly. (Noise monitor)
- The use of quiet voices. (Voice monitor)
- Each member takes turns. (Turn-taking monitor)

Functioning: This level requires that the group can achieve its goals and maintain fair and effective working relationships. A number of roles can be assigned to ensure that this can occur. The key elements of this level include:

- Record and edit the group reports. (Recorder)
- Ensure that all members contribute to the group and praise individual contributions. (Encourager of Participation, Praiser)
- Ensure the group has a direction and has clear guidelines for the completion of an assignment. (Direction Giver)
- Clarify statements by the group members. (Clarifier/Paraphraser)

Formulating: This requires that students are able to formulate what they have learnt and are able to integrate this into their assignment or learning task. Some of the key elements of this level include:

- There are accurate statements of the group's major conclusions from work either written or oral. (Summariser and Accuracy Coach)
- There is a need to extend answers to questions that go beyond those given by the groups. All group members should understand and be able to explain the answers of others. (Generator and Checker of Understanding)
- Research needs to be undertaken for materials or concepts required by the group. (Researcher)

Fermenting: This level requires students of the group to 'ferment' their ideas and to draw conclusions through thorough review, justification and explanation. Key elements and roles that help the group to achieve include:

- Criticize and justify ideas to ensure that they are well thought through. It is important that group members carrying out this role criticize ideas but not the person who suggested the idea. Mutual respect is paramount.

- Differentiate between different group members' ideas ensuring that everyone is clear on differences between various viewpoints.
- Probe and extend through in-depth questioning leading to deeper understanding and obtaining more information to achieve this.
- Integrate the ideas and opinions into single statements that the group can agree on and ensure that such statements match the requirements of the assignment or task set.

Johnson and Johnson (1999) suggest that higher-level roles such as formulating and fermenting do not occur naturally within a group but will develop over time. It is often better to introduce these roles later.

The Five Basics of Cooperative Learning

Johnson and Johnson (1999) maintain that many educators fail to create effective cooperative learning groups by simply listing a few of the characteristics of good group work such as 'work together' or 'be a team'. They argue that effective cooperative learning 'is a regime that if followed rigorously, will produce the conditions that are required for cooperative learning' (p. 75).

Brown and Thomson (2000) in their review of the Johnson's work coined the acronym PIGSF (Pigs Fly) to list the basics of cooperative learning.

1. Positive interdependence
2. Individual accountability
3. Group processing
4. Small group and interpersonal skills
5. Face to face promotive interaction

1. Positive interdependence

This is essential if a group is to succeed and the quote from Alexandre Dumas, cited by Johnson and Johnson (1999), stated 'All for one and one for all' as one of the keys to the success of a cooperative learning team. The philosophy of 'sink or swim together' (p. 5) requires a suitable structure in place to enable the group to properly develop these skills. Three steps have been put in place in order to accomplish something beyond individual success.

The first step is assigning clear measurable tasks so that all group members know what is expected of them and that they must each contribute to the tasks if the group is to succeed. It is critical to understand that effort is required from all members for the group to succeed, and that there are no ‘free riders’.

The second step is to structure positive goal interdependence in such a way as to ensure that all group members know that they cannot succeed unless all group members of their group succeed. The group members must be united in their aspiration towards a common goal, and need to ensure that they all learn the assigned material. Some of the indicators used to ensure that this occurs include monitoring their relative scores as individuals with time; they should be improving and above a set standard. The sum of individual scores within the group should be above specified criteria and members must successfully complete a single set of answers for the group if that is required.

The third step is supplementing positive goal interdependence with other types of positive interdependence such as tangible rewards when a task is successfully completed. The learning of each member of a group needs to be observed, recognized and rewarded. Positive rewards can include celebration of their joint success when all members reach a set criterion, or the addition of bonus points to the scores of all members when the group reaches set criterion. Non-academic rewards such as time out, stickers and food, are also options. Another suggestion is to assign a single grade for the combined efforts of the group, but Johnson and Johnson (1999) recommend caution when using this option until all students and parents are familiar with cooperative learning.

Johnson and Johnson (1999) have found a range of teaching strategies that encourage various types of positive interdependence. Some of these strategies include:

Positive identity interdependence: This is where a mutual identity can be established through a team name, motto, icon or song. Brown and Thomson (2000) go a step further with a range of suggestions on how a real team can be established (see the section on Brown and Thomson below).

Positive resource interdependence: This is where the team has to share one set of materials in order to complete the assigned task. This ensures good cooperative teamwork.

Positive role interdependence: Can be established by rotating the roles assigned to each member of the group. These roles are complementary and interconnected which the group needs to complete for success in a given task such as a practical where one role may be the equipment manager and another the recorder.

Positive goal interdependence: This requires all group members to have a set of mutual goals that can be achieved only if each of the members attains his/her goals. A product such as a concept map including team members' roles can assist in achieving this interdependence.

Positive outside enemy interdependence: This is the term coined by Johnson and Johnson (1999) to allow for inter-group competition in which a strong feeling of interdependence is established as they try to beat other groups.

2. Individual accountability

'The purpose of cooperative groups is to make each member a stronger individual in his or her own right' (p. 29) is a basic philosophy of Johnson and Johnson (1999). Students not only learn the skills of working in groups but also are able to perform to a higher standard on their own. Students need to acquire a sense of responsibility to learn well themselves and also assist the learning of their teammates. They cannot achieve this if they simply 'hitchhike' on the work of others but ensuring compliance needs to be done in a non-threatening manner. Students will not commit to the risk of failure unless they feel they are in a safe learning environment.

Suggested strategies to help ensure individual accountability include the following:

- Working in smaller groups increases the individual accountability.
- Individually testing each student on occasions.
- Random oral examination is where the student is asked to report to the teacher with the group present or to the class as a whole.

- Observing each group to record the frequency with which each member contributes to his or her group.
- Assign a role of checker who asks other group members for an explanation of the group answers.
- Ask students to teach others what they have learnt (simultaneous learning).

3. Group processing

Groups are to reflect on their own progress and analyse their functioning in a particular group session. The purpose of group processing is to clarify and improve the effectiveness of members' contributions to the collaborative efforts to achieve their group's goals. Johnson and Johnson (1999) recommend that some student-based starter ideas be provided to help them with the reflection process. These include specifying aspects their group did well and others that they could improve on, the need to reflect on things that each member may have done to improve the group effectiveness, and the process of self-assessment by individuals on how they have contributed in a particular skill area such as encouraging others and telling others how their contributions are appreciated.

There are five steps outlined below on how to structure group processing in order to continuously improve the quality of the groups task work and teamwork as suggested by Johnson, Johnson, and Holubec, (1993). The first step is systematic observation of the students at work, which allows an insight into how the groups and their members think and operate. The degree of understanding of major concepts and strategies being learned as a group, along with the ability of members to work effectively together, are useful observations in terms of improving their cooperative learning. Such observations can be made by the teacher or by students appointed on a rotational basis. A simple checklist will help students to establish patterns of interaction and contributions amongst the group.

The second step is to provide feedback on the process by which the group does its work. Using checklists of data collected to ensure that the contributions of all members are recognised can provide such feedback. Feedback helps to establish good working relationships and facilitates the learning of cooperative skills.

Reflection is an essential part of self-evaluation and a key to maintaining a high standard of work and cooperation among the group members.

The third step is for the members to set goals for themselves and their groups on how to improve the effectiveness of the group. Goal setting should come from suggestions that the group decides to adopt.

The fourth step is to measure how the whole class is performing. This can be a simple summary near the end of a lesson by the teacher or from student observers within each of the groups.

The fifth is the celebration of success by both individual groups and the whole class. Success has a big impact on how students perform in later activities. Reflection is very important and can be best summarized by a quote from the ex-coaching director of the New Zealand Rugby Union, Bill Freeman who said, 'feedback is the breakfast food of champions' (NZRFU rugby coaching conference Wellington, New Zealand, 1993).

4. Small group and interpersonal skills

Students need to be taught the cooperative skills necessary to succeed. Simply placing unskilled students into a group does not guarantee success. Students need to learn the academic subject matter in their group along with the skills of working in an effective team. They will not learn academic material if their teamwork is inept. The need to engage in task work and teamwork simultaneously requires that members must know and trust each other, communicate succinctly, and be able to resolve any conflicts in a constructive manner.

5. Face-to-face promotive interaction

The physical environment provided for the students is important to help the group to succeed. Students need to be seated to ensure that they can establish eye contact with one another while working. Their meetings need to be appropriately scheduled. The progress of the group can be easily observed in this way. It is easy to observe if students are encouraging one another and reviewing their ideas. Oral summaries by the students of their group's work should be used along with evaluation and challenges if required. The good groups will be seen to lean towards each other and concentrate on what is being said.

Reducing problem behaviours

When a group member is not contributing or exhibiting negative influences such as off task behaviour and disrupting other members, Johnson and Johnson (1999) have a range of simple corrective strategies. These include structuring the task to ensure that it cannot be completed or a reward is withheld if all members do not contribute. Jigsaw tasks, reward structure and the careful assigning of key roles for group members all work well.

Summary

Johnson and Johnson (1987, 1989, 1991, 1994, 1999) are regarded as leaders in the field of cooperative learning and they often provide analogies with the key elements of successful sports teams where members will often exhibit loyalty, commitment and effort well beyond what would be expected from an individual acting alone. Playing on in the face of serious injury in a key rugby or basketball game are common examples. They establish structures and conditions where a successful cooperative team is most likely to succeed as opposed to a pseudo-learning group where students are simply put into groups to perform various tasks. It is acknowledged that while high performance cooperative groups are rare, educators can move their groups towards this goal through a well-structured cooperative learning programme.

Elizabeth Cohen

Elizabeth Cohen (1986) focuses mainly on how a cooperative group operates. She states that if the group is to work to its potential, a group needs to work within a well-established structure, and therefore should be more effective than individuals working alone. Most students will have had limited exposure to effective cooperative group work and as a result need to be taught this. Cohen used the concept of a *norm,* which is simply a rule for how one ought to behave. When the group members accept and display evidence that they are operating to a suitable set of *norms* the norms have become *internalised.*

Cohen emphasises the need to ensure that all students in a group participate equally, including less successful students (usually of low status within the classroom) who often struggle to contribute to discussions and learn less. High-status students tend to dominate group discussions. Groups need to review their own performance for the contribution of individuals within the groups. Are group members all talking, listening and asking questions about other members' ideas or suggestions? Cohen (1984) found that students who talked and worked together more learned more from the curriculum than those who talked and worked together less.

Cohen (1994) later establishes strategies to help students of differing ability to become integrated into the group (referred to as multiple ability groups). Such integration is achieved mainly through carefully designing tasks and assigning expectations to each student according to ability. Providing taylor-made tasks for them gives all members competence to achieve. Cohen considered that there are two major patterns of working together, namely, *pure cooperation* and *collegial model* and within these basic structures there are some variations that help them to become more effective.

<u>Pure cooperation</u>

This requires students to come to a consensus on the group's response to a question. Students must harmonise and compromise while working closely together to achieve the task. Consequently, group members may have to give up some of their ideas. Cohen suggested that because the group may have to deal with emotions and conflicts, which can hurt feelings, other methods are used to modify this model. One such modification is to appoint a facilitator whose role is to ensure that the task is completed and everyone participates without anyone's feelings being hurt.

<u>Collegial model</u>

This model requires students to assist one another while working on the same task. At the basic level students will assist each other with skills such as comprehension, reading and problem solving. At a higher level, students who understand more difficult problems get to explain and teach others in their group. These more able students are also often able to convince others who may normally think that even their best effort will lead to failure. Cohen (1986) sees this type of peer motivation as an important element of the collegial model.

> Students can and do teach each other in the collegial model. This is undoubtedly its major advantage over the conventional method of requiring individuals to work alone. Peer explanations are often excellent, and those who explain often show intellectual gains as a consequence (p. 56).

Cohen points out that while there may be drawbacks in the group receiving a group grade for group efforts, many teachers feel that the group members may lack the motivation required to perform to their best. It is also unwise to evaluate individual student's contributions to a group product because factors beyond the individual student's control may have contributed to this. Failure of an individual should be viewed as a failure of a group-work technique.

Cohen also advocates the use of competition between teams as an additional motivational factor while Slavin (1995) advocates that individual member marks in an examination should be added to make up the group score. Essentially both Cohen and Slavin advocated the use of competition between groups as a motivational tool for individuals within each group.

Brown and Thomson

Don Brown has vast experience in the fields of psychology and education in New Zealand, whereas Charlotte Thomson has a background as a teacher and a psychologist. Both are involved in the teacher development programme at Victoria University of Wellington.

Skills and the New Zealand curriculum

Brown and Thomson in New Zealand place a high emphasis on teaching of the relevant skills that enable students to operate effectively in a cooperative group. Much of their work (Brown and Thompson, 2000) is based on the structure set up by Johnson and Johnson (1987, 1989, 1991, 1999), and clearly acknowledged as very influential. Brown and Thomson (2000) also refer to the work of Kagan (1994), which states that students must have both the *will* and the *skill* to work effectively in a group. After careful examination the essential skills listed in the New Zealand Curriculum Framework (NZCF) document (Ministry of Education, 1993) Brown and Thomson see that while the primary school sector often addresses the skills of teamwork and interpersonal skills this is not always the case in the secondary sector where many teachers see their responsibility as being subject-based only. Brown and Thomson examine both international and national trends in the development of the modern curriculum where there is a trend to integrate skills, attitudes and values along with 'deep' thinking and learning processes.

The NZCF recognizes that competence and achievement are strongly associated with attitudes to learning and there are also frequent references to equity, life-long learning skills, cooperation and achievement. It is argued that many of these attitudes and skills, along with individual responsibility, are difficult to learn effectively in the competitive, individualistic environment typically encountered in New Zealand secondary schools.

Whereas New Zealand maybe viewed as multicultural, its bicultural foundations are seen as very important in our education. Brown and Thomson refer to the work by Glyn and Bishop (1995), which suggests that Māori-preferred teaching and learning styles, along with cultural practices, are largely supported by cooperative learning strategies. The adoption of such styles and practices could be advantageous to both Māori and other students.

In some of his earlier work, Brown (1992) was able to establish that many New Zealand secondary school students value the help they receive from their peers. After a six month trial in some New Zealand secondary schools one of the students working in cooperative groups made the statement: 'Other people were able to help me to better understand the topic. It helped me also to be teaching other people because it helps me to remember a large amount of work (p. 19)'.

Brown and Thomson (2000) maintain that all students' thinking is stimulated by cooperative learning processes, supporting studies by Johnson and Johnson (1992) and Cohen (1994). That some students are able to explain concepts and ideas to students of lower ability is mutually advantageous.

Establishing effective cooperative groups

Brown and Thomson (2000) suggest that time, thought and effort must be invested in the students to get them to work cooperatively. The needs for successful cooperative work have already been described in detail; Brown and Thomson list the following four common threads.

1. Build positive relationships and a sense of belonging to the group.
2. Encourage mutual support for each other in their learning.
3. Ensure that all students' efforts are seen to matter through empowerment and the fostering of self-responsibility.
4. Learning needs to be an enjoyable experience with an element of having fun.

Some aspects of an effective cooperative classroom, which apply throughout the entire room, include involving students in the establishment of class rules and norms for all to operate under. The students then 'own the rules'. Once the link between rights and responsibility is established the class should forge ahead.

Individual group establishment

Brown and Thomson (2000) outline three key aspects when initially establishing their cooperative groups as follows:

1. The type of group (based on the work of Johnson and Johnson, 1994) where the group can be:

- Informal: This is used for quick and short-term work or tasks, possibly for less than one lesson.
- Formal/generic groups: This type of grouping is the most common where students get the opportunity to work on longer-term tasks or projects; there is often a demand for higher-level thinking.
- Base Groups: This is like a long-term home for the students or more like a family, which can endure the entire year.

2. There are also three recommended methods of assigning students to their groups (Brown and Thomson, 2000)

- Random selection: This is seen as a fun way to establish the teams (as noted earlier). Such a selection process is recommended for use at the beginning of the year when students can get to know other students in the class.

- Student Selection: This is really social grouping in that students chose their own group. Brown and Thomson (2000) suggest that caution is needed when using this method of group selection. They suggest that there can be more off-task behaviour and at times some students are left out and feel 'loners'.
- Teacher Selection: The teacher is in charge of this type of group with a number of options open to them such as whether they are going to be of mixed ability and how the high achieving students fit in. Heterogeneous groups are generally considered the best for learning.

4. The size of the group is important with a general suggestion of Brown and Thomson (2000) that 'four and no more' (p. 67) is a good rule of thumb. Equipment supply and the relative experience of the students also need to be taken into account. One of the advantages of starting with pairs is that they can be doubled up later to make fours.

Teaching the Skills

Brown and Thomson (2000) follow the paradigm that teaching relevant skills and applying them is an integral part of successful cooperative learning. This is a view shared to a large extent by Johnson and Johnson (1987, 1989, 1991, 1999), and Kagan (1994), who maintain that the best place to teach teamwork skills is in the context of authentic teamwork activities. The teacher needs to know which skills to teach and how to teach them.

Brown and Thomson break down teamwork skills into task skills and working relationship skills.

Task Skills

Task skills are focused on the content of the task such as writing reports, planning and analyzing data. Other task skills include the generation and elaboration of ideas, an ability to remain focused on the task, time management, an ability to follow instructions, and continued planning and reviewing of the process. Groups exhibiting these skills are invariably successful in their outcomes.

Working Relationship Skills

These skills are focused on the building of positive relationships within the group in an atmosphere of mutual support and care. Examples of working relationship skills include acknowledging the contribution of individuals, checking for agreement or disagreement in a non-confrontational manner, encouragement and appreciation of other team members.

Stages in Teaching the Skills

Brown and Thomson (2000) believe that the teaching of cooperative skills is no different from the teaching of other skills to students. The main steps to achieve this are:

Step 1. Establish the need for the skill. Teachers and students need to be aware of the skills required for successful cooperative group work. One of the most effective methods found by teachers for establishing such a need is to undertake some cooperative group work and then to reflect as a group or even as a class on its success or otherwise. Identifying the skills required for a group to function successfully is often established by the students themselves and hence it could be argued, gives them 'ownership' of these skills and thus a greater desire to acquire them.

Step 2. Define the skill. Students need to be clear as to which specific skill is being taught, for example, 'encouraging participation'. There are many activities and methods that can be used to help students define various skills.

Step 3. Guided practice. Teachers need to provide opportunities for groups to practice skills, and then observe and monitor each of the groups in action ensuring that they get appropriate and positive feedback.

Step 4. Generalised application of the skill. Students need to given opportunities to apply the skills learnt in a wide range of contexts. Student reflection and understanding of other potential applications of the skills are also important.

Brown and Thomson also suggest that the use of roles in their groups is also helpful in helping them take responsibility for their own group management. Roles such as timekeeper, on-task monitor, recorder and organiser are frequently used over the full range of student ages.

2.2.3 Overview of cooperative group work

While the concept of cooperative group work may be thousands of years old there has been a considerable amount of research done within the last century in the so-called 'modern era'. While there are a number of differences in the establishment and organization of cooperative groups between the various researchers there are a number of common elements, which include:

1. The need for the group to enjoy learning and have fun working together with a real sense of belonging.
2. The need for the group to have achievable and measurable goals.
3. The need to work cooperatively together in order to achieve higher levels than would be achieved as individuals.
4. The need to try to ensure that all members of the group contribute to the group and are individually accountable.
5. The need to ensure that there are suitable structures and tasks in place to assist students in the development of the appropriate cooperative skills required for group success.

Many of the tasks and structures suggested by various researchers, while successful require a considerable input of teacher time and expertise, which may present some difficulties for the modern secondary school teacher.

The following section looks at the development of the concept of attitudes and how they may in fact be measured. This is essential if there is in fact a link between successful cooperative group work and improved attitudes towards science.

2.3 ATTITUDES

2.3.1 The Evolution of the Modern Concept of Attitudes

Shrigley, Koballa and Simpson (1988) suggest that Fleming (1967) provided the most significant study about attitude as a modern concept. Fleming (1967) points out that around the turn of the 18th century artists used the term attitude largely to describe the posture of a stationary figure and later actors and dancers performing. This sense is still retained in a secondary role today where the term attitude is used to describe events such as an aircraft in flight. Fleming credited Charles Darwin as being the first to associate emotion with the concept of attitude when he used it to describe the emotional readiness of animals in a state of crisis. Shrigley, Koballa and Simpson use the work by Thomas and Znaniecki (1918) to explain the attitudes and morale of the early Polish immigrant farmers in the United Sates. Thomas and Znaniecki (1918) tried to understand unexpected results in productivity that arose when the physical demands of workers and work conditions were changed. They eventually invoked attitudinal and psychological explanations when physical reasons such as fatigue did not sufficiently explain production figures in the industry.

Fleming (1967) claims that it was primarily Thurstone (1928), with his manifesto 'Attitudes can be measured', who ensured that attitude would remain because it could now be quantified. Shrigley (1983) notes that Likert who followed Thurstone, simplified the process with an item analysis technique, which allowed the data of respondents of statements to also serve as measures of validation (Likert, 1932).

Despite the term 'attitude' having very popular current usage, the meanings given to it can vary considerably (Koballa, 1988). Its widest meaning includes many educational objectives and outcomes other than those that are essentially cognitive or physical (Mathews, 1974). Shrigley (1983) maintains that attitude is central to human activity yet education researchers have had considerable difficulty understanding it, because it often appears inconsistent and even fickle. Some are tempted to abandon it or even deny its existence. Shrigley stated that it is generally agreed that attitude is not innate, but learned as part of culture. Shrigley (1988) suggested that feelings are central to attitudes towards science or toward a particular scientific concept or phenomenon. The three parts of the attitude trilogy are affection, cognition, and conation.

Some of the critical differences in the reactions of one child with those of another to their schools expectations are often a function of their intelligence and differences in their preferences, attitudes, drives, needs, interests and values. Often a student may exhibit a disinterest in a particular subject and as a result be viewed as a poor student while in another subject in which they are interested, may be seen as intelligent. A positive attitude towards a subject may not necessarily equate to an interest though an attitude implies a disposition to react in a particular manner towards that subject. Getzels (1969) maintains that it is our interests rather than our attitudes that drive us. The attitude 'behaviour-link' appeals to many science education researchers but there is an element of uncertainty surrounding this link in the eyes of some researchers. Shrigley, et al (1988) suggest that 'the relationship of attitude and behaviour is probably correlational rather than literal.' (p. 676)

Education research has focused attention recently on affective outcomes particularly attitudes. This attention has arisen because affective variables are seen to be just as important as cognitive variables in influencing, and possibly predicting, learning and other outcomes (Koballa, 1988). Shrigley, et al (1988) suggest that there is much confusion surrounding the fundamental principles of attitudes. Some of this confusion involves mixing concepts of attitude with belief and value with opinion. Shrigley (1983) derives the following composite definitions of the key elements to the attitude concept:

1. Attitudes are learned; cognition is involved.
2. Attitudes predict behaviour.
3. The social influences of others affect attitudes.
4. Attitudes are readiness to respond.
5. Attitudes are evaluative; emotion is involved. (p. 438)

2.3.2 The Development of Instruments for the Measurement of Attitudes

In a study to revise and validate a Likert (1932) science attitude scale for young scientists by researchers, Misiti, Shrigley, and Hanson, (1991) comment that 'during the middle school years attitudes are formed that influence science course selections in the high school and college' (p. 525). Following on from this, if there is not a positive student attitude towards science then career choices of the best students probably will not include the sciences and engineering. Consequently, development and validation of attitude measuring instruments needs to be maintained if research into attitudes is to be continued. According to Germann (1988) attitude researchers must clearly define the construct being investigated and its place within the larger theoretical framework. They must then demonstrate the reliability and validity of the instruments used to measure it. This has not always been the case and there are difficulties comparing findings that use different terminology but measure similar attributes or, conversely, using similar terminology but measuring different attributes (Brophy & Good, 1986). Fraser (1978c) points out that there are three important problems associated with several instruments to assess attitudes to science. These include low statistical reliability, a lack of economy of items, and often conceptually distinct attitude dimensions being combined into a single scale and thus presenting a confusing mixture of variables.

Attitudes towards the science disciplines have been assessed since the 1960s and one of the earliest and frequently quoted examples was a study by Perrodin (1966). Perrodin (1966) examined over 500 fourth, sixth and eighth-grade students in the United States. His assessment was in the form of open-ended statements such as 'The study of science is more important than…'. The students completed these questionnaires and then the data were summarised and categorized by Perrodin to make final qualitative judgments.

Moore and Sutman (1970) developed and field-tested the *Scientific Attitude Inventory* (SAI) for use with secondary school students to test for intellectual and emotional attitudes towards science. The SAI comprises 60 items ranging from knowledge of laws or theories of science to feelings about being a scientist. After investigating 30 studies of the SAI, Munby (1983) questioned its validity, noting that it was the most popular attitude instrument at that time. Baker (1985) described the SAI as having two scales, one positive and one negative. He calculated the total attitude score by subtracting the negative scale from the positive. Other studies using the SAI did not report the method of calculation nor separate scales (Munby, 1982). Moore and Foy (1997) revised SAI but did not report any changes to these conceptual difficulties. Thus, doubts of validity continue to be raised (Munby, 1997).

Many instruments for the measurement of attitudes have now been developed, with the majority following Likert's (1932) style that sums rating scales (Gardner, 1975a, 1975b). Fisher's (1973) 20-item Likert scale for junior high students was developed using a jury of science curriculum experts to generate area of interest within the attitude object. Statements were then written to match each subcomponent. This instrument had good correlations, reliability and internal consistency. The Likert scale has a different point scale for positive and negative statements reflecting their degree of agreement with that statement. It should be noted that an important feature of the Likert scale is that their intention is often obvious to respondents who could fake the responses to reflect more positive or negative responses. This is why it is important that the students know that there are no 'marks' for this and their response sheets are anonymous if possible. The Likert scale is presented in Table 2.1.

Table 2.1.
The Likert Scale

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Negative Statement	1 point	2	3	4	5
Positive Statement	5 points	4	3	2	1

Klopfer (1976) alleviated the semantic problems caused by the multiple meanings attached to the term 'attitude' to science. Klopfer classified six categories of conceptually different attitudinal aims (Shulman & Tamir, 1972).

Development of the Test of Science Related Attitudes (TOSRA)

The above format was chosen by Fraser (1977a, 1977b, 1977c, 1978a, 1978b) in the development of TOSRA which itself is based on the affective part of Klopfer's

(1971) taxonomic classification of objects in science. Fraser distinguished seven distinct school science-related attitude scales following Klopfer (1976). The relationship between Klopfer's classification and Fraser's TOSRA scale is illustrated in Table 2.2.

Table 2.2

Fraser's Scales (TOSRA) and Klopfer's Classification

Scale name (TOSRA)	Klopfer (1971) classification
Social Implications of Science Normality of Scientists	H.1 Manifestation of favorable attitudes towards science and scientists
Attitude to Scientific Inquiry	H.2 Acceptance of scientific enquiry as a way of thought
Adoption of Scientific Attitudes	H.3 Adoption of scientific attitudes
Enjoyment of Science Lessons	H.4 Enjoyment of science learning experiences
Leisure Interest in Science	H.5 Development of interest in science and science related activities
Career Interest in Science	H.6 Development of interest in pursuing a career in science

Fraser (1978b) supports his scales by noting that Klopfer's 'Manifestation of Favourable Attitudes Towards Science and Scientists' were in fact two distinct sub-categories with some related attitudes. Fraser included the 'Social Implications of Science' because it was supported in the literature (Zoller and Watson, 1974; Fraser, 1977a) as being important in that it measured attitude towards the social benefits and problems often associated with scientific progress. The Normality of Scientists scale was linked to Klopfer's manifestation of favourable attitudes towards scientists because the students almost invariably depict scientists as eccentrics rather than normal people (Mead & Metraux, 1957; Fraser, 1977b). Klopfer's H2 scale is directly reflected in Fraser's Attitude to Scientific Inquiry scale.

Cohen (1971) suggests that Australian scientists see the Adoption of Scientific Attitudes as very important in their work as scientists hence this scale is included by Fraser in the TOSRA. The final three scales in the TOSRA, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science, are directly related to those of Klopfer H4, H5, and H6 (Table 2.2). Fraser then selected a pool of items from groups of science teachers and experts in educational measurement for each of the seven scales. This pool generated a 14-item version of TOSRA, which was, then field-tested and reduced to 10 items per scale after statistical item analysis outlined in Fraser (1977c).

Other researchers have constructed well-designed attitude scales. Simpson and Oliver (1985) produced a seven-item Likert scale that measured the attitudes of students in grades 6-10. Wareing (1982) developed a 50-item scale for students in grades 4-12 and included validity tests involving a jury process and a readability test.

Misiti, Shrigley and Hansen (1991) revised and validated an older unpublished Likert science attitude scale for young students. They made comments about juries used and the readability of items. They held informal discussions with sixth graders and identified words that expressed positive and negative feelings towards science. Positive words were cool, radical, decent, far out, out of sight, gnarly and bad. Words denoting negative feelings were: weird, dumb, a drag, boring, lame and retarded. These terms may change over time and location but, along with readability, are very important in the development of an instrument for the measurement of science-related attitudes.

There are some contradictory results from various studies on science attitudes. These may simply be due to measurement of different concepts. Attitude differences were often noted for girls and boys (Simpson & Oliver, 1990). Of 120 eighth grade school students, females were reported to have had a more positive attitude toward science than males (Baker, 1985). In an investigation using the SAI, Willson & Lawrenz, (1980) reported, 'increased positive student attitude toward science' and 'attitude toward the learning environment'. These are both vague terms and difficult to compare with other studies, so results of these studies should be interpreted with caution.

The Enjoyment of Science Lessons scale (see Appendix C) from Fraser (1981a) has often been modified by some researchers and used as the basis for scales to assess student attitudes. A recent example of this is the 7-item scale on Attitude To This Class (Table 2.3). This scale has been used by Fisher, Rickards, Goh, & Wong (1997a, 1997b), Henderson, Fisher, & Fraser (1994, 1995, 2000), Henderson & Reid (2000), Kim, Fisher, & Fraser (1999, 2000), and Yaxley, Fisher & Fraser (2000).

Table 2.3

Items in the 'Attitude to this Class' (Enjoyment of Science Lessons) Scale (Fraser, 1981a)

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

The Enjoyment of Science Lessons scale (also named Attitude to This Class) has been widely used in its own right and in statistically significant associations with other classroom environment instruments such as the Questionnaire for Teacher Interaction (QTI) in many studies including the original Dutch study by Brekelmans, Wubbels and Créton (1990).

2.3.3 The Changing Attitudes of Boys and Girls Towards Science

Students often experience substantial changes in their learning environment between Year 6 and 10. This includes late primary (often intermediate schools in New Zealand) and the early secondary school systems. This time also marks a period of significant other changes in the students' lives, which may also influence their attitudes. Whereas there have not been many studies which have focused entirely on this transition there have been a number of significant studies.

Gender, age and changes in attitudes

In a comprehensive study of three state schools in Hawaii, Greenfield (1997) concludes that 'younger students expressed more positive attitudes towards science than did older students' (p. 268). His research involved the use of observation in categories such as off-task, on-task or misbehaving along with the use of detailed surveys, which were based on three short questionnaires. The first questionnaire the *Student Attitude Questionnaire* developed by Simpson and Troost (1982). This instrument assessed student attitudes about various aspects towards science in school and included several subscales such as attitude towards curriculum, and science anxiety. The second and third surveys (Mason & Kahle, 1988) included the *Perceptions of Science and Scientists Survey* and the *Experiences Survey* in which the students identified the type and frequency of science activities in which they have participated outside school. The main points were that whereas boys and girls had similar attitudes toward science younger students were more positive than older ones. The girls' attitudes, however, did decline more over the years than did those of the boys. There was little difference in their perceptions of scientists and careers in science except that the boys were more likely to view science as a masculine career requiring a high level of intelligence. Boys suggested that they had more experience in science related activities outside the classroom and within the classroom there was a perception that boys received more attention than girls but girls still sought it as often as the boys. There was also a suggestion that carefully constructed laboratory work can be effective in ensuring that girls are as active during practical work as boys.

Changes in attitudes during the transition from primary to secondary school

Ferguson and Fraser (1998) examined the effect of gender and school size on the changing perceptions of science-learning environments during the transition from primary school to secondary school. This study was fuelled by the growing concern that some secondary school subjects, in particular the sciences, are perceived negatively by some students, predominantly girls (e.g. Speering & Rennie, 1996). Other studies have also noted that gender may influence learning environment perception (e.g. Terwel, Brekelmans, Wubbels, & van den Eeden 1994; Fisher, Fraser, and Rickards, 1997). Student responses during the transition from primary to secondary may be influenced by gender (Speering & Rennie, 1996; Ferguson & Speering, 1997), and further, gender-based experiences resulting from the transition may in fact lead to girls developing persistently negative attitudes towards the science curriculum. Furthermore, Cotterell (1992) suggested that the relative change in school size might be an important factor in student perceptions.

These findings, based on quantitative data, therefore suggested a negative change in student perception of the learning environment during the transition from primary to secondary school. The boys had a more negative perception of the primary school learning environment than did the girls. The qualitative data also supported this conclusion. The perceptions both of boys and girls of the learning environment moved much closer together at secondary school.

Qualitative data collected suggested that boys and girls had different priorities when describing the 'positives' about the school environment with the girls placing more importance on relationships within the school contexts, both with peers and teachers. Boys, however, were more concerned with equipment and facilities and the type of experiences. Teacher relationships were not seen as important unless they were very poor. Boys saw only peer relationships as important when they allowed for specific shared activities such as sport.

In conclusion, there is a considerable body of research that suggests that many of the learning environment perception changes are related in some way to the transition pathways in particular school size change. Most transition programmes treat all students in the same way and assume that any difficulties encountered are the same across the particular cohorts. In general, students who have experienced a greater relative change in school size find that classroom cohesiveness is considerably reduce Cotterell d (, 1992).

Assessment and 'test anxiety'

Research on equitable assessment strategies by Parker and Rennie (1998) looked at the effect of the test-taking situation on attitudes and in particular 'test anxiety' which varies according to the situation. Parker and Rennie highlighted the work of Adams (1986) and others who showed that the success of students in a stressful testing situation is dependent on the degree to which they are confident that they will succeed and that boys in these situations tend to be more confident than the girls. Hembree (1988) suggests that test anxiety could be exaggerated when students are uncomfortable with the test-taking situation.

2.3.4 Self-Efficacy, Science Literacy and Group Work

No study on attitudes and young people would be complete without some reference to self-efficacy. Prof Albert Bandura of Stanford University, regarded by many researchers as a top world authority on self-efficacy, defines self-efficacy (Bandura, 1986, p. 391) as “peoples judgments of their capabilities to organize and execute courses of action required to attain designated types of performance.” Essentially it is confidence in ones own ability which in turn can influence (Bandura, 2004):

- The choices we make.
- The effort we put forth.
- How long we persist when we confront obstacles (and in the face of failure).
- How we feel.

Bandura (1994) maintains that self-efficacy is one of the key factors in self-motivation.

> Self-beliefs of efficacy play a key role in the self-regulation of motivation. Most human motivation is cognitively generated. People motivate themselves and guide their actions anticipatorily by the exercise of forethought. They form beliefs about what they can do. They anticipate likely outcomes of prospective actions. They set goals for themselves and plan courses of action designed to realize valued futures (p. 75).

Unlike attitudes, science self-efficacy has only been investigated in recent years with work by researchers such as Baldwin, Elbert-May and Burns (1999) who developed an instrument to measure science self-efficacy.

There has been little research in New Zealand on the development and validation of instruments to measure self-efficacy although Dalgety, Coll and Jones (2000) developed and validated an instrument for use with tertiary chemistry students, Chemistry, Attitudes and Experiences Questionnaire (CAED). The effect on self-efficacy of cooperative group work and assessment could be significant but is regarded as beyond the scope of this study.

Science literacy also has an effect on the attitudes of the entire population towards science and how they might view any science-related issues. Many students find science difficult because of a lack of science literacy. Whitaker and Salend (1991) investigate the effectiveness of collaborative peer writing groups and make the statement that “students with disabilities frequently lack the self-esteem and interpersonal skills important to collaboration” (p. 132). They go on to establish that students can improve literacy through work in cooperative groups.

2.3.5 Attitudes and the Classroom Environment

When changes are made to the learning environment of a classroom through strategies such as cooperative group work it is also likely that there will a shift in the general classroom environment. While the focus of this study is on the effect of cooperative work and assessment on student attitudes an awareness of research that can link an improvement in classroom environment with better student learning outcomes is valuable. In a literature review by Fraser (1998) the existence of associations between classroom environment and student outcomes is supported.

The Questionnaire on Teacher Interaction (QTI) originally developed in the Netherlands and was later followed by a shorter version for the Australian Science education scene (Wubbels. Creton & Hooymayers, 1985; Wubbels & Levy, 1993). One of the features of QTI which makes it so useful (Coll & Taylor, 2000) is the fact it has two versions, one which measures the students perceptions of the actual teaching style achieved in the classroom and the second version which measures the preferred teaching style. This enables classroom teachers to readily identify any specific areas of mis-match and make appropriate adjustments to their teaching style.

There has been little use of the QTI made in New Zealand at secondary school level although there was a significant study by Coll and Fisher (2000) at tertiary level in some chemical technology classes at second and third year. This revealed any discrepancy between teachers' and students' perceptions of the learning environment and the students' actual and preferred environments. QTI could be a useful instrument in the assessment of cooperative work on the classroom environment.

2.4 CONCLUSION

Cooperative group work has been shown in the literature to have ancient beginnings however it really began in earnest from the early 1970s. There have been many significant contributions from researchers of how cooperative groups can be best established and maintained in an efficient and productive manner. Many of the outlined techniques may be very effective in a primary school where students remain with one teacher for extended periods of time. However these techniques are not always suitable in secondary schools where students are with a teacher for periods of less than one hour and then followed up by a new class of students usually of a different year grouping. Glasser (1969, 1986) suggests that there are many failures at secondary school level and effective group work is possibly an effective method to best address this issue. There are some elements of the group work outlined in the literature which are suitable for use in secondary schools without a significant increase in teacher workload in the management of cooperative learning in his or her classroom. Kagan (1998) suggests that cooperative group work without changing the content or curriculum delivery is a good way forward for many teachers who may not want to set up elaborate cooperative based lessons. The cooperative group work structures used in this study are outlined in the methodology (Chapter 3).

Koballa (1988) states that there has been a shift in the focus of education research in the past few decades to affective outcomes particularly attitudes. This shift has arisen as affective variables are now seen as being as important as cognitive variables in influencing (and possibly predicting), learning and other outcomes. The review of research leading to the modern understanding of attitudes is followed by attempts to quantify this through the development of a range of instruments. Several of these are more suited to science-related attitudes such as the TOSRA by Fraser (1981a) than others. It should be noted that the term 'science' in these instruments encompasses many aspects of science such as student interest in science outside the school laboratory environment and general impressions of scientists. The impact of assessment and its effect on student attitudes is also included in the review with the suggestion by researchers such as Adams (1986) that the 'stress' encountered by students during assessments can be reduced if the students are more confident of success. The literature review certainly supports the concept of cooperative group work and the importance of student attitudes is seen as paramount. There is however no reported research into how simple cooperative group work suitable for implementation by secondary school teachers may in fact influence the science-related attitudes of students. The combination of cooperative group work and assessment is not always seen by researchers such as Kagan (1994) as ideal where students gain a combined mark for some assessments, however there is significant research to suggest that ‘embedded assessment’ does in fact lead to improved science learning rather than just summative assessment (Treagust, Jacobowitz, Gallagher & Parker, J. 2001).

This study is unique in that it attempts to change students’ attitudes and to measure such changes, through the use of the simplest form of cooperative group work in predominantly laboratory work and assessed activities such as tests and assignments. Chapter 3 describes the methodology used in this study.

It is hoped that this study will:

- Provide secondary school teachers with a simple effective method of improving the science related attitudes of our younger students without a subsequent increase in workload. In fact if followed through the workload would in face be significantly reduced.
- Provide a positive environment where students can gain the rewards of working with their friends, better grades in their assessments, and the benefits of peer explanations and discussions while in their groups. This should have a positive effect on their understanding and hence enjoyment of science so often perceived by students as too difficult.

CHAPTER 3

METHODOLOGY

3.1 OVERVIEW

Whereas a significant amount of research has targeted cooperative group work and the changing attitudes of students during their formative years at secondary school, there has been little research carried out into effective and simple ways to attempt to reverse the well-documented deterioration in student attitudes towards science (Yarrow, Millwater, & Fraser, 1997). Therefore, in this regard, this study is valuable in that it focuses on this problem by using a triangulated approach to assessing student attitudes. Qualitative data are collected from two sources, the students and the teachers through interviews and after thorough examination of the available instruments the TOSRA (Fraser 1981a) was seen as most suitable for use in New Zealand to assess student science-related attitudes quantitatively. The TOSRA has been extensively field tested in Australia and the United States and by providing validation data teachers and researchers throughout New Zealand can then use this instrument with confidence to assess attitudes towards science in New Zealand schools (Appendix C).

This chapter is comprised of a discussion of the early pilot study at the author's own school, which led this study being continued as a worthwhile project which could make a difference to students' science-related attitudes. There is a description of how the other schools for the study were selected together with how extraneous variables were minimised. The selection of year levels and the bands of classes are then discussed along with an account of the teachers who were able and willing to take part in the study.

Protocol for the establishment of the groups (learning teams) within the classes is discussed followed by the guidelines given to students and their teachers on how to work together during activities such as practical sessions, assignments and tests (written and practical). Ethical considerations are also discussed in the chapter.

The method of quantitative data collection using the TOSRA is then discussed because this was administered before the students embarked on their group work and assessment study in term one and again later in term four when the study was completed. The qualitative data collection methods are outlined and include techniques such as student and teacher interviews, video taping of assessment activities and personal observations.

The aim of this study was to determine the effect of cooperative group work and assessment on the attitudes of students towards science in New Zealand. Specifically, the research set out to gauge the effects of group work and assessment on the attitudes towards science of Year 9 and Year 10 students.

In the long term it was hoped that the following might be achieved:

- minimising the impact of the perceived difficult aspects of science by making the students feel more secure during class work and during the assessment procedures carried out in many New Zealand schools; and
- encouraging students to work cooperatively towards achieving a common goal, whether the goal is to complete an assignment, a practical activity, fieldwork, or an assessed exercise.

Establishing small cooperative groups in which the students performed all their assignments, tests, laboratory work and fieldwork was the basis for this. All members of the group received the same mark for any given assessment exercise and students were encouraged to communicate and work cooperatively during these activities. Increased teacher input to the groups during these activities was also encouraged.

The bulk of this thesis is based around the period of study in 1998, however following suggestions from teachers' who participated in study, and the researcher's own more recent classroom teaching, there have been a number of modifications made to the basic format for cooperative group work. Many of these additional approaches have proved to be a successful addition to the basic philosophy outlined in the study and as such have been included in Chapter 7 later in this thesis.

3.2 SCHOOL SELECTION

3.2.1 Pilot Study

There was a significant amount of preliminary investigation conducted at a rural New Zealand school termed School 3. This pilot study involved testing a class of Year 10 science students taught by the researcher in 1996. This gave the researcher some data, which suggested cooperative group work and assessment had real potential and as such demanded further investigation.

The science staff were enthusiastic about new methods and approaches to their teaching incorporating cooperative group work and assessment and was willing to participate in further study on a more formal basis. Hence School 3 was targeted for more extensive study.

It was also recognized that it was not possible for the researcher to control all of the variables in this research. There are a several aspects of the classroom-learning environment and student-teacher interpersonal behaviour, which cannot be controlled during the study and the best that can be hoped for is to minimize the effect of these independent variables.

3.2.2 Description of Schools Selected

Since School 3 was already targeted for more extensive study it was wise to look carefully at its general features to ensure the prudent selection of other similar schools hence reducing the variables and improving the statistics.

School 3

School 3 and its farmland (mainly dairy) community are situated 30 kilometres from Hamilton, located centrally in the Waikato region of New Zealand. The surrounding farmland is one of the most closely settled rural areas in New Zealand, and consists mainly of dairy farms with lesser numbers of beef, sheep, deer, and goat and horticulture units. The size of the retail and service centre of the town reflects the closely settled farmland, and the high level of associated industries. Between 10% and 20% of the population is of Māori descent. There are four marae (in New Zealand a marae is a traditional Māori communal meeting place of spiritual significance) within the town's community.

There is a smaller but significant community of Dutch origin, and a number of Indians and Chinese. The school is coeducational with a population that ranges between 610 and 750 students. Approximately 50% of the students travel to school by bus.

In New Zealand a decile rating is a measure of the school's community wealth. School communities are rated on a scale of 1 to 10, with 1 being the poorest and 10 the wealthiest (the lower scales are further subdivided into 1A, 1B, etc, for funding purposes) (Education Review Office, personal communication, August 7, 1999,). School 3 has a decile rating of 6 and is State owned and operated.

It was decided to try to work with similar schools in the Waikato region for ease of travel and observation during the study and fortunately the two closest rural coeducational schools were willing and enthusiastic about participating in the research. These two schools had a similar mix of students and the junior school (Year 9 and 10) in particular was structured in the same way in terms of banding and ability of their students. The structure of the classes for Year 9 and 10 students was similar for each of the three schools. Each school allocated students into ability bands, with a top ability band of two or three classes followed by three or four mixed-ability classes. The Heads of Science at each of the participating schools had enthusiastic staff keen to contribute and help with the research and were able to select the classes without having to take staffing into account. A description of each of the selected schools follows. Both Schools 1 and 2 are within 25 minutes by car of School 3. These three rural Waikato schools had no lower bands of students (classes of lower ability band students at the time of this research were very rare anywhere within New Zealand) that would be able to participate in the research hence School 4 was selected. School 4 is in southern South Island.

School 1

School 1 is situated in a mainly dairying community situated 45 kilometres from Hamilton on the edges of the Waikato and Thames Valley provinces. The town services the region with the retail turnover closely reflecting the needs of the nearby farmland. The ethnic composition is predominantly Pakeha (people of European descent) with approximately 8% of the population of Māori descent from one main marae. There are a few Indian students and several Polynesians. From time to time there are South East Asian students from refugee backgrounds. There are significant Dutch and Swiss cultural minorities who maintain close contact with their home countries. A number of these are recent immigrants whose English is limited. The college is coeducational with a population that varies between 420 and 460 students with close to 50% traveling to school by bus. School 1 has a decile rating of 5.

School 2

School 2 is situated 45 kilometres from Hamilton on the plains of the Waikato region. It has been the home of one main tribe of people for many generations. Pakeha settlement since 1895 has been based on farming – dairying, and horse breeding on the plains and sheep and cattle on the rolling hill country. With this background, the area is viewed today as a farming community with an urban service town. Recently, vigorous and significant industrial activities have developed and these serve the town, New Zealand and international markets. The school is approximately 13% Māori. The school population is around 760 students and close to 50% of the pupils travel to school by bus. School 2 has a decile rating of 7.

School 4

School 4 was selected, as it is one of the few schools, which has a selected lower ability class. Schools 1, 2 and 3 all have broad banding consisting of a top band and a mixed ability band. School 4 had the same structure but also contained a lower band of 18 students, none of whom had behaviour problems that are common among lower band classes. However, it is a slightly different type of school from the others. It still is an essentially rural coeducational school but it has a larger population of close to 1,200 students. There are only a few Māori students at this school. It is situated in the town of Invercargill, significantly larger than any of the other towns associated with this study, in mainly sheep farming country. School 4 has a decile rating of 8.

3.3 SELECTION OF CLASSES

Twelve Year 9 and 10 classes from Schools 1, 2 and 3 were used for the data collection, four classes from each school. Since these schools used a broad-banding system for the streaming of their students, an upper band of two classes and then mixed ability classes, it was decided to use one class from each of these bands at each year. The rationale behind the selection of bands of students at all years was that it was important to see the effect of cooperative group learning and assessment on students of all abilities, not just the top students. Each of the classes contained between 25 and 30 students, as is most common in state rural secondary schools. A lower ability class of 18 students from School 4 was added to the study and this class was selected on the basis that it contained students who were finding progress difficult but did not pose any significant behavioral problem.

The selected teachers were enthusiastic and willing to participate in the research and a significant number were often teaching classes at each ability level, both mixed ability and the upper band within the same year. This was helpful as the students in both ability bands received the same classroom procedures at each year, which helped to reduce the variables, and would give a valuable comparison between ability bands.

Even though there were limited numbers of teachers available to participate in the study at each school, it was possible to select teachers with a range of experience and of both genders (Table 3.1).

Table 3.1
Summary of Teachers Selected

Teacher	Gender	Teaching Experience (Years)	School, Class, Year and Band
A	Male	< 5 years	S1: Year 9M, Year 9U
B	Male	> 15 years	S1: Year 10U, Year 10 M
C	Male	> 15 years	S2: Year 9M, Year 10U
D	Female	< 5 years	S2: Year 9U, Year 10M
E	Female	< 5 years	S3: Year 9M
F	Female	< 5 years	S3: Year 9U
G	Male	> 15 years	S3: Year 10M
H	Male	> 15 years	S3: Year 10U
I	Female	5 to 10 years	S4: Year 10L

Bands U = Upper M = Middle L = Lower

3.4 HOW THE GROUPS WERE ESTABLISHED WITHIN THE CLASSES

While much of the research outlined in Chapter 2 suggests that self-selected groups do not always make the best learning teams, the twin ideals of simplicity for the teacher and fun-but-purposeful for the students were seen as paramount. The teachers were instructed to use their own 'common sense' as their students selected their groups. Assisting students to establish their groups in a fair manner was seen as an important part of the process.

The use of triads for the purposes of this work was a student recommendation following the pilot study at School 3. Students saw this as an ideal number for ensuring that they were all involved with less chance of having 'passengers' during any team activities. The use of the terms 'group' or 'learning team' is of interest. The literature in general refers to a 'learning team' as a group, which has progressed to become a 'learning team' through more effective communications and operation. The term group is used in general throughout this study.

Students were each given a handout, which outlined the practical details of how they were to choose their groups and what would be expected of them during class work and assessments (Table 3.2).

3.4.1 Protocol For Group Organisation

Table 3.2
Student Instructions

1	Students are able to select their own group of preferably three.
2	They are to do all practical, fieldwork, assignments and tests working in these groups.
3	Each member of the group receives the same mark for tests, assignments, fieldwork and any other assessments.
4	Students are given handouts regarding each type of assessment.
5	All work and assessment is essentially cooperative, students are encouraged to share the workload and enjoy working together, whether it is an assessed activity or a simple experiment.
6	Students will be instructed in suitable ways of ensuring that all group members participate and have a sense of ownership of the results. For example, tasks such as collecting and using equipment are always rotated to make sure that everyone has a turn.
7	Students are instructed to ensure that each group member is given a specific task and that they are responsible for completing that task on time. The group then collates all of the contributions from each group member (this is often one member's task). The master assignment is marked and each member receives the same mark along with a copy of the final assignment
8	For written tests, students are arranged in their groups at the laboratory benches to allow them to work together with a minimum of contact with other groups. Eye contact should be possible among group members. Talk within the group is permissible but talk between groups is not. Answers are to be handed in and marked. All group members receive the same grade.

3.4.2 Instructions to Teachers

There was significant dialogue between the researcher and the teachers to try to ensure that the approach towards the work during this study was consistent.

The teachers all agreed with the basic philosophy of trying to ensure that the students found science an enjoyable and rewarding experience. The group testing aspect of the study was seen as very important as they had found students were often 'stressed' when doing tests in the past.   Many of the teachers said during discussions that they had often felt uncomfortable giving our Year 9 students formal tests when many of these students had never experienced tests other than Australian Science tests. (Australian Science is a multiple choice resource based testing programme set up by the University of New South Wales and used extensively by schools on both sides of the Tasman.) Teachers were told that the opportunity existed to assist students with their examination techniques while doing the tests in their groups.

The dialogue between the researcher and teachers at this stage was extremely valuable as consensus was reached between both parties about the best way to ensure that our students all made the best progress possible. The teachers all emphasised that the students were aware of and appreciated what was being attempted during this study. This partnership was essential if all participants in the study were to have a sense of 'ownership'.

A summary of the instructions to teachers is presented in Table 3.3.

Table 3.3
Teacher Instructions

1	There is essentially no change to the content of the students' course of study or the general way in which it is delivered.
2	It may be possible to include a few more strategies that are more suited to the cooperative group work approach such as investigations (both written and practical) and problem solving activities linked to the current topic.
3	Some groups would need more help in establishing good working relationships than others and teachers would need to try and ensure that all groups operate well. This is made easier by the fact that the whole group gets the tangible reward of grades in any assessment that they do together. Some group restructuring may be necessary if problems appear insurmountable, although such restructuring should be rare.
4	During written tests opportunity exists to help all groups with their approach to problems encountered during tests. This is not possible with a full class of students sitting tests as individuals. It is a good idea to treat the early tests in particular as a formative process and not just summative. One of the main thrusts of the research is to improve student attitudes towards science and helping them with problem solving activities under test conditions is a good vehicle to help achieve this.
5	During written assignments and practical work students may need help in assigning tasks to each group member. It is important that these tasks are rotated throughout the group where possible to ensure a fair sharing of workload and a sense of worth among the group members.

3.4.3 Ethical Considerations

Participation of the teachers was voluntary. The parents of students involved in this study were informed about the study and had the opportunity to withdraw their children from aspects of the study if they so wished. This would have meant that the students would continue with their regular course work but would not be asked to complete a TOSRA form or agree to be interviewed. They would have still completed any assessments, however, because the study only focused on the way the students were assessed and worked together. No problems were anticipated if all the involved parties were well informed.

Confidentiality was maintained during the course of the study and numbers rather than names were recorded. Anonymity and confidentiality were accorded to all participants and they were encouraged but not forced to contribute to this study.

Before the teaching programme began, the selected classes were fully informed and then profiled. Additional data collected included the year grouping and gender. The participants were briefed on the type of work and assessment procedures they were to experience over the next three terms. These briefings provided an outline of the type of approach that the classroom teachers used in the programme. It was not the intention to alter the content of the material that was normally presented to the class or the assessment programme, only the way students were organised and completed their assessments.

3.5 QUANTITATIVE AND QUALITATIVE DATA

Both quantitative and qualitative data were collected for this study over the first three terms of the school year (to avoid the end-of-year examinations held during November). The student's class, band and year, along with the school were obtained. The gender of the student was also collected (Appendix B).

3.5.1. Quantitative Data: TOSRA Application

The TOSRA was seen as the most appropriate instrument for use with the Year 9 and 10 New Zealand students. A full description of the TOSRA and its development as a valid instrument to measure the attitudes of students can be found in Chapter 2.

Teachers administered the TOSRA in early May of 1998 and repeated this in late November in the same year when their work with the cooperative groups was concluded. The students' names were not recorded on the TOSRA answer sheets to help ensure the students answered the questions frankly. The teachers ensured that the students had plenty of time to complete the TOSRA and any student questions were answered during this time thus helping to ensure the accuracy of the student responses. The lower level class at School 4 was given more help during the administration to ensure that they fully understood what was being asked before they responded.

3.5.2. Qualitative Data

As with any study involving humans and their behaviour there will always be considerable variation of ideas and thoughts expressed by individuals. A range of methods of collecting qualitative data was used.

Observed sessions and videotaping

The researcher made first-hand observations of students working in their groups (as did their teachers on a more regular basis). Some sessions were videotaped. The videotapes allowed for later examination to see how many students were on or off task in each group and who were contributing most, at least verbally (although the most verbal may not always be on task all of the time). Once the students realised that their initial concerns about the camera were unfounded, they simply got on with their work.

Audio taped student and teacher interviews

Student Interviews

The second approach to collecting qualitative data involved interviewing students and teachers. There were two groups of students randomly selected for interviews from each class giving a total of 26 groups in the four schools. There were usually nine groups of three in each class. The interviews were all taped in a quiet room or outside in a quiet spot where the students felt comfortable and able to answer the questions freely. As is the accepted practice with all of this type of research, students were always asked if they were happy to be interviewed. They were usually very positive about the possibility of interviews and in the end provided the researcher with good knowledge of their basic feelings about many aspects of the project.

A set of basic questions was asked of all groups (Table 3.4). There were some more open-ended questions, which could be asked of any groups who seemed keen to expand on the previous questions for example. The prompts were used to ensure questions were always fully answered. Students were also given plenty of opportunity to comment on any issues arising from the study; this included any recommendations from a student perspective seen as important or indeed any ideas seen as worth pursuing. As is the normal protocol for interviews, the question was always put first to the learning team before the tape was started. This meant that the students could ask any questions about what was meant by any particular question without long pauses and continual rewinding of the audiotape.

Table 3.4
Questions for Interviews with Students:

Q	Student questions
1.	**Group work: Establishment.** a. How did you sort out your group? b. How are you enjoying working in your group? c. Are there any things that you have changed since your group was first formed?
2.	**Practical work, research & assignments:** When you are doing practicals, research or assignments, how do you divide up the jobs? **Prompts*:*** • Do you keep changing the jobs? • Has it changed? • What do you do if one of your group is slacking a bit? Do you, give them a rev, etc. etc
3.	**Group work: Effectiveness.** Do you think that your group efforts are better than you would produce as individuals? **Prompts:** • Why? [If yes] • Why not [If no]
4.	**During tests:** a. Does the same person write up the answers? b. Has one person become 'the boss'? c. How do you sort out your group's answer, if some of you group disagree with other members of the group? d. How do you think your results are compared to sitting the tests as individuals, better or worse? **Prompt:** • Why? e. Do you think you will do better at the end of year exams having worked in groups than you would if you had done all of your tests as individuals? **Prompt:** • Why? **Prompt: [**If necessary] • Do you think that by doing your tests in groups you are also learning? f. If you were given the choice of working in groups or as individuals for the next test what would you choose?
5.	**Ease and enjoyment** a. Do you find science easier when you work in groups? b. Do you find science more enjoyable when you work in groups?
6.	**Relevance** Does group or teamwork have any application to being in the 'workforce'?

Teacher Interviews

Each of the participating teachers was invited to be interviewed and all responded positively. A basic set of questions was used but they were not as structured as for the students, thus allowing teachers an opportunity for significant input into the study. The teachers had been helpful in helping to ascertain and justify the types of research questions that needed to be asked during a study such as this. Teachers were asked to monitor any of the modifications that were made to any groups and why this had occurred. During the observation phase, and along with any videotaping of students at work in their teams, teachers were also asked if there were any special and successful ways of managing the teams through different strategies that they found to be particularly useful.

The heads of science at each of the study schools also allocated time during their regular Science Department meetings for all of their science teaching staff to make comments and recommendations on the study as they saw it.

3.6 DATA COLLECTION TIMELINE

The data were collected on five occasions during the year (Table 3.5). Schools were visited during term one where data was obtained on class composition, bands, year and general observations on how the classes were operating before the study. There were other observation visits during the latter part of term two and the early part of term three. On these occasions videotaping of tests and other team based activities also occurred. The teachers administered the TOSRA early in term two and again towards the end of the year, well before the final school examinations.

Qualitative data were collected from student and teacher interviews near the end of the year in November. The teacher interviews were held after the student interviews.

The classroom teachers, following instructions from the researcher, administered the TOSRA. They were administered in the early part of the day to try to get all the students to take them seriously. The questionnaires were given to the teacher in an envelope with clear instructions on it. The completed questionnaires were often collected by students and were then placed straight into the sealed envelope. This helped to ease any student anxiety about their teachers reading the responses. The researcher discarded any informal responses. The personal data collected on the TOSRA sheet were sufficient to allow a statistical analysis of the responses.

Table 3.5
Data Collection Timeline

1998	Action
Term 1	Observation and class composition data collected
Term 2	Early term 2 first administration of science attitudes instrument (TOSRA)
Term 3	Observation and videotaping of team activities
Term 4	Term 4 second administration of science attitudes instrument (TOSRA) Student interviews for qualitative data. Staff interviews for qualitative data

There were some changes in class numbers and some moving of students because some changed schools (usually 1 or 2 students from each school in the study). These changes, when considered against the total number of students participating in the study, were seen as insignificant and as such were deleted from the records.

3.7 DATA ANALYSIS

The data analysis focuses on the objectives of the study, the first part of which was to provide validation data for the use of the TOSRA in New Zealand. The measures used to validate the TOSRA were a factor analysis, the Cronbach alpha coefficient (Cronbach, 1951), to assess the internal consistency of the scales, and the mean correlation of a scale with the other six scales (discriminant validity).

Having validated the TOSRA, the second objective was to determine the effect of a cooperative approach to learning and assessment on attitudes of students to science. The scale means and the t test scores were used to identify any statistically significant variations among the results ($p<0.05$ and $p<0.01$). These results were backed up with qualitative data obtained from student and teacher interviews to give a three-pronged approach to the significant variations.

The third objective was to determine relationships of grade and gender of students with their attitudes to science and look for any other possible contributing factors such as school and teacher on the science attitudes of the students in the sample population. The data were analysed using the SPSS software package.

3.8 ONGOING STUDY

A number of the students who participated in the pilot study have progressed well beyond the time of main study and there are some significant data available on the success of these students. This essentially allows a longitudinal study of the results.

From the group of 31 Year 10 students involved in the preliminary study by the researcher at School 3 in 1996 a significant number (13) were still at school as Year 13 students in November 2000 when more quantitative TOSRA and qualitative data were collected to add a small yet significant group of students to the overall study. The results of this longitudinal case study are outlined in Chapter 6.

CHAPTER 4

VALIDATION OF THE TOSRA

4.1 OVERVIEW

The first object of this study was ‘to provide validation data for the use of the Test of Science Related Attitudes (TOSRA) in New Zealand’. The development of instruments to measure attitudes has been outlined in Chapter 2 where the TOSRA was found to have wide use and acceptance by education researchers.

Validation of an instrument is essential in any research that needs to make statistically significant comparisons between any groups of students. A significant part of this study is the collection of quantitative data collected by the administration of the TOSRA to the students involved in the study.

However, even though students from different countries including Australia may exhibit similar attitudes, it cannot be assumed that an instrument shown to be valid beyond New Zealand would necessarily apply to New Zealand students. There is a need to validate the TOSRA before any results from research can be considered valid.

The attitudes of the students towards science were measured using the TOSRA (Fraser 1981a). This instrument consists of 70 items with items spread equally between seven distinct scales, Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. Each of these items had five possible responses based on the Likert (1932) scale, which the students simply circled. The possible responses were: Strongly Agree, Agree, Not Sure, Disagree, and Strongly Disagree. There are a number of negative items for which the scoring is reversed. These are randomly distributed throughout the scales.

The TOSRA is suitable for group administration during the course of a normal lesson. Some of the students at times did find that this was a bit confusing, as they had ‘already been asked that question’. It was always made clear that they were to answer each question as a separate item regardless of what had been asked previously. Most of the students were able to complete the TOSRA easily within the

35-minute time slot allocated for it. The lower band of students at School 4 had their questions read to them and hence their questionnaires took about 50 minutes to complete.

The TOSRA has been carefully developed and extensively field-tested in Australia and the USA. It has been shown to be highly reliable, however, it has not yet been used extensively in New Zealand. Therefore, one objective of this study was to determine its reliability and validity for use in New Zealand schools. The TOSRA was used before and after the students embarked on their cooperative group work and assessment tasks. This chapter uses the data gathered in 13 classes in Years 9 and 10 in four coeducational schools in New Zealand. The validation of TOSRA makes a significant contribution to the assessment of science related attitudes in New Zealand.

A comparison of the mean scores of the New Zealand sample with similar groupings from Fraser's (1981a) work has been made at the end of this section. While they are only mean scores it does give us a quick overall comparison between the groups of Years 9 and 10 students within the two countries.

4.2. RELIABILITY AND VALIDITY OF THE TEST OF SCIENCE RELATED ATTITUDES (TOSRA)

The TOSRA was administered to a sample of 312 Year 9 and Year10 students in 13 coeducational science classes in rural New Zealand. The measures used to validate the TOSRA were a factor analysis, the Cronbach alpha coefficient (Cronbach, 1951) to assess the internal consistency of the scales, and the mean correlation of a scale with the other six scales (discriminant validity).

4.2.1 Factor Analysis

A further analysis of the instrument involved a principal components analysis with varimax rotation (Table 4.1). The 70 items were analysed to determine the

Table 4.1

Factor Analysis of the TOSRA

Scale	Item Number	Factor 1 Leisure	Factor 2 Inquiry	Factor 3 Social	Factor 4 Enjoyment	Factor 5 Normality	Factor 6 Adoption	Factor 7 Career
Adoption of Scientific Attitudes	4			0.44			0.39	
	11							
	18						0.39	
	25			0.34			0.31	
	32						0.57	
	39			0.5			0.31	
	46		0.47					
	53						0.59	
	60		0.34					0.33
	67						0.41	
Career Interest in Science	7	0.56						
	14	0.55						
	21	0.58						
	28	0.57						
	35	0.53				0.34		
	42	0.59						
	49	0.57		0.46				
	56	0.56						
	63	0.33						
	70	0.64						
Enjoyment of Science Lessons	5	0.38			0.55			
	12	0.47			0.56			
	19	0.64						
	26	0.36			0.37			0.35
	33	0.49			0.54			
	40			0.37	0.34		0.32	
	47	0.47			0.48			
	54						0.39	
	61	0.47			0.45			
	68							0.48
Attitude to Scientific Inquiry	3		0.64					
	10		0.45					
	17		0.69					
	24		0.60					
	31		0.66					
	38		0.68					
	45		0.69					
	52		0.65					
	59		0.46					0.21
	66		0.55					
Leisure Interest in Science	6	0.66						
	13	0.51						
	20	0.67						
	27	0.64						
	34	0.63						
	41	0.59						
	48	0.65						
	55	0.56						
	62	0.64						
	69	0.50						
Normality of Scientists	2							0.39
	9					0.59		
	16			0.39		0.41		
	23					0.61		
	30				0.33	0.55		
	37					0.53		
	44					0.44		
	51					0.66		
	58					0.54		0.35
	65					0.43	0.31	
Social Implications of Science	1				0.53			
	8			0.36	0.31			
	15			0.31	0.49			
	22			0.47				
	29	0.48			0.35			
	36			0.38				
	43			0.44	0.34			
	50			0.73				
	57			0.35				
	64			0.63				

commonality of factors measured. The seven factors are listed across the top of the table with the items and scales down the side. It was noted that a number of items appeared in the 'wrong' scale column and it was felt best to delete these items from the original scale and rework the statistics since the responses were not specific to a given question. There was some thought given to combining Leisure Interest in Science and Career Interest in Science since many of the items were factored into the same scale, but with a total of 19 items in a new combined scale it was a lot bigger than the other scales. All of the correlations were greater than 0.31 with the bulk of them being at least 0.55 or greater, which can be considered as a satisfactory correlation.

As a result of the factor analysis a number of items were omitted from a number of the scales (table 4.2).

Table 4.2
Items Changed after Factor Analysis

Attitude scale	**Item(s) retained**	**Item(s) omitted**
Social Implications of Science	50, 64, 22, 43, 36, 8, 57	1, 15, 29
Normality of Scientists	51, 23, 9, 30, 58, 37, 44, 65, 16	2
Attitude To Scientific Inquiry	38, 31, 52, 3, 24, 66, 59, 10, 17, 45	None
Adoption of Scientific Attitudes	25, 53, 32, 18,67	4, 11, 39, 46, 60
Enjoyment of Science Lessons	40, 47, 12, 5, 33, 26	19, 54, 61, 68
Leisure Interest in Science	20, 6, 48, 62, 27, 34, 41, 55, 13, 69	None
Career Interest in Science	70, 42, 21, 28, 56, 7, 14, 35, 63	49

4.2.2 Validation of the TOSRA

Table 4.2 shows that there was an acceptable level of reliability, i.e., greater than 0.60 for six of the seven scales (Nunnally 1978), when the individual student is used as the unit of analysis with alpha coefficients ranging from 0.75 to 0.88 for these six scales. This is well within acceptable values for this type of application. The exception was the Adoption of Scientific Attitudes scale, where only four of the original questions remained after the factor analysis and which had an alpha reliability of 0.52, which is on the lower side of acceptable limits. Results using this scale need to be treated with some caution. Generally, however, these results are similar to the original of a range of 0.69 to 0.84, reported by Fraser (1977c) and attest to the internal consistency reliability of the TOSRA.

4.2.3 Mean Correlations

The discriminant validity of the instrument was measured using each scale's mean correlation with the other scales. The mean correlations range from 0.25 to 0.42 using the individual as the unit of analysis (Table 4.3). This range indicates that the items used in the instrument correlate far more with items in the same scale than with items in other scales. Consequently, the instrument has satisfactory discriminant validity and each scale measures generally distinct although somewhat overlapping attitudes.

Table 4.3
Scale Means: Standard Deviations, Internal Consistency (Cronbach Alpha Coefficient), and Discriminant Validity (Mean Correlation with Other Scales) for the TOSRA

TOSRA Scales	Number of Items	Scale Means	Standard Deviation	Alpha Reliability	Mean Correlation with other Scales
Social Implications of Science	7	3.27	0.58	0.75	0.40
Normality of Scientists	9	3.44	0.56	0.76	0.25
Attitude to Scientific Inquiry	10	3.77	0.65	0.83	0.24
Adoption of Scientific Attitudes	5	3.41	0.51	0.52	0.42
Enjoyment of Science Lessons	6	2.95	0.83	0.88	0.40
Leisure Interest in Science	10	2.43	0.78	0.85	0.37
Career Interest in Science	9	2.75	0.74	0.80	0.33

(n = 312)

4.3 COMPARISON WITH PREVIOUS STUDIES IN 1981

Because this is the first time TOSRA has been used extensively and validated in New Zealand, it is well worth comparing these results with a similar grouping from Fraser's (1981a) original use of the TOSRA in a range of schools in Brisbane and Sydney where the sample size ranged between 324 and 340 Year 9 and 10 students (Table 4.4; Figure 4.1).

Table 4.4
Comparison of New Zealand and Australian Means for TOSRA

Attitude Scale	New Zealand Study Scale mean	Australian studies Scale Mean
Social Implications of Science	3.27	3.65
Normality of Scientists	3.44	3.61
Attitude to Scientific Inquiry	3.77	3.71
Adoption of Scientific Attitudes	3.41	3.82
Enjoyment of Science Lessons	2.95	3.24
Leisure Interest in Science	2.43	2.59
Career Interest in Science	2.75	2.77
	n = 312	n = 324

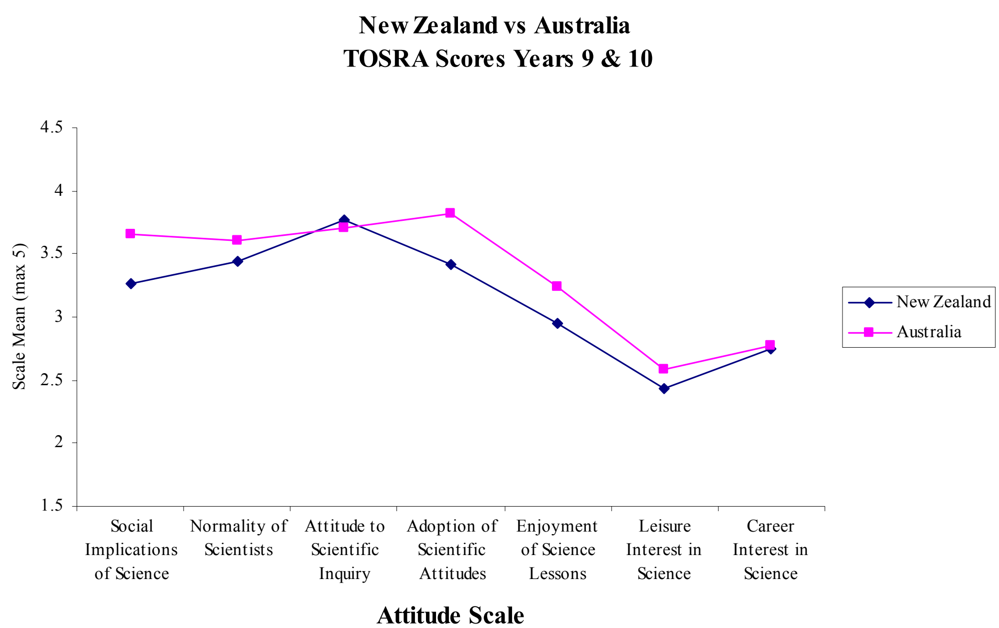


Figure 4.1. TOSRA mean scores for New Zealand and Australia

4.4 CONCLUSION

It has been one of the purposes of this study to validate the TOSRA and this chapter has outlined through descriptive statistics how this was achieved. It has shown that the TOSRA with some modifications is a reliable and valid instrument for New Zealand conditions and students.

The original 70 items have been reduced to 56 to ensure that the items with the strongest interscale correlations are retained. The scale for Attitude to Scientific Enquiry has changed the most with only five of the original ten items being retained in the final form of the instrument. However overall, the results of the validation indicate that the TOSRA can be used with confidence with the students throughout the study.

The findings for this instrument in New Zealand are similar to previous findings from Australian samples of secondary school science students of the same age and year level. A comparison of the two sets of results shows that generally the New Zealand results may be a slightly lower for most of the TOSRA scales, except for the Attitude to Scientific Enquiry and Career Interest in Science, where the results are essentially identical. It should however be noted that the drawing of conclusions about these small differences on student attitudes in different countries and in a time frame spanning two decades is probably only speculation.

Overall, the final version of the TOSRA, with some modification, is a valid and reliable instrument for the measurement of students' attitudes towards science in New Zealand Schools. The pattern and trends are very similar to those shown by Fraser (1981a) and as such its use is justifiable.

CHAPTER 5

GENDER AND ATTITUDES TO SCIENCE: SCHOOL, YEAR AND BAND

5.1 OVERVIEW

The second objective of this study was 'to determine relationships of grade and gender of students with their attitudes to science'.

Quantitative data were collected using TOSRA on two different occasions throughout the school year with the first administration occurring in May, which was before the cooperative group work was started, and the second in November at the completion of the work. Total student numbers were 312. The decision was taken to investigate comparisons of science related attitudes within the various subgroups using the November TOSRA results because the patterns and attitudes of students within the particular class environment would have been well established by then and the students had been working in cooperative groups for three terms.

This chapter explores the use of the TOSRA in firstly comparing the relative attitudes of boys and girls within the whole sample. Then the effects of gender are considered in bands and years, with any significant variations in the TOSRA scales between the genders being discussed. The significance of the school, along with the year and bands, are then analysed and discussed. There is some consideration given to possible effects of the science teacher on the attitudes towards science in any given class.

The final analysis reported in this chapter is the comparison of all student attitudes by band. Finally, the significance of all the results is considered in the chapter discussion.

5.2 GENDER AND SCIENCE RELATED ATTITUDES USING THE TOSRA

5.2.1 Gender and Attitudes[1]

The effect of gender taken across the entire sample in November 1998 was analysed using the TOSRA (Table 5.1).

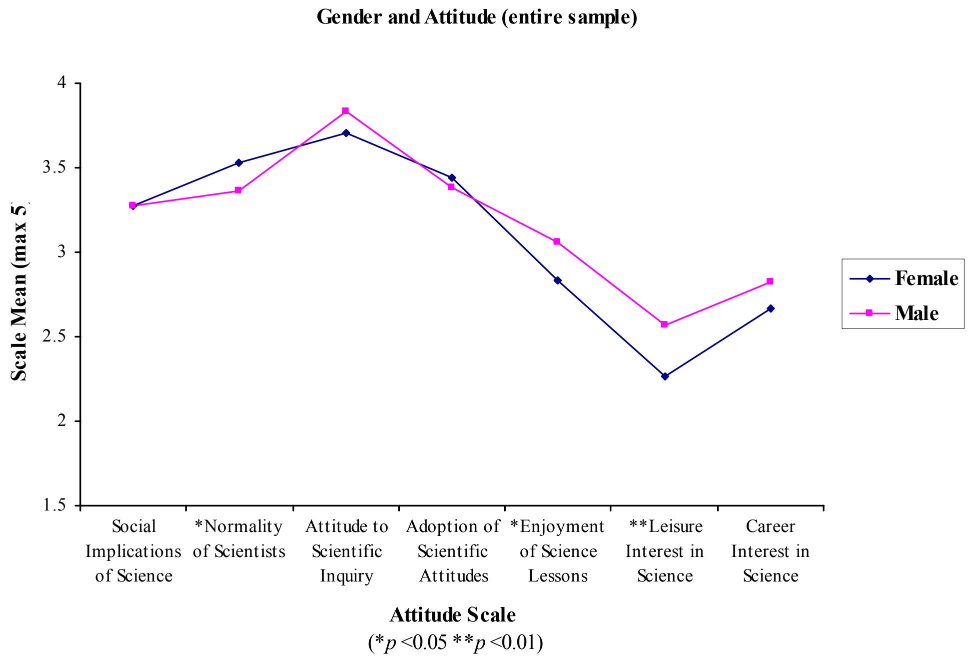
Table 5.1
Gender and Attitudes: TOSRA Results for the Entire Sample

Attitude scale	Females (Scale mean)	Males (Scale mean)	Difference	t
Social Implications of Science	3.27	3.27	-0.00	-0.05
*Normality of Scientists	3.53	3.36	0.17	2.66*
Attitude To Scientific Inquiry	3.71	3.83	-0.12	-1.51
Adoption of Scientific Attitudes	3.44	3.38	-0.06	1.11
*Enjoyment of Science Lessons	2.83	3.06	-0.23	-2.37*
**Leisure Interest in Science	2.26	2.57	-0.31	-3.46**
Career Interest in Science	2.67	2.82	-0.15	-1.81
*p<0.05 **p<0.001	n=146	n=166		

These results are shown graphically in Figure 5.1 where the graph is based on the item mean scores for each scale. The line graph has been traditionally used to present data when using instruments such as the TOSRA since it allows for easy comparisons between the scales.

[1] *In the interests of teacher privacy all teacher names given throughout this chapter are fictional.*

Figure 5.1. Gender and attitude (all students).



Discussion of results: Gender and attitudes

As can be seen from the results above there are some statistically significant variations in the attitudes of the two subgroups. The females showed a significant difference for Normality of Scientists from the males, with females viewing scientists as more normal than male students. In a paper by Greenfield (1997) on gender and differences in participation, one of the strongest findings was that girls, more than boys, believed that females are just as capable of studying science and going on to become scientists as males and hence see this as normal. Greenfield (1997) went on to suggest that this viewpoint may be because many had 'strong' female science teachers at lower level. The large numbers of female teachers compared with males at primary schools (most schools have less than 5 males from a staff of 35) supports this idea.

The males show a significantly greater Enjoyment of Science Lessons. There could be a range of reasons for this finding, such as the traditional idea that males commonly participate more in hands-on activities, which may mean they enjoy experimental work more than females. It would however be necessary to obtain data on a larger population to justify such a conclusion. The study revealed that the males scored higher on Leisure Interest in Science scale than did the females. Fraser (1981a) noted that the highest scale inter-correlations occur between the scales Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. While these scales are conceptually distinct, they are expected to be reasonably well correlated because there would be a tendency for a student who enjoys science lessons to be more likely to have leisure and career interests in science. In a study by Jones, Howe, and Rua (2000) on the attitudes and experiences of 437 11 and 12 year old students, males reported more extracurricular activities with a variety of items such as batteries, electric toys, fuses, microscopes and pulleys. They also had more interest than the females did in atomic bombs, atoms, cars, computers and X-rays. Their female counter-parts were more likely to have experiences with bread making, knitting, sewing and planting seeds. The females also had more general interest in animal communications, rainbows, healthy eating, weather and AIDS. Females wanted more 'to help other people' while the males reported that science was often destructive, dangerous and more suitable for boys. This possibly leads to boys expressing a greater degree of leisure interest and enjoyment in science.

5.2.2 Gender and Attitudes: Years and Bands

This population was derived from all of the schools except School 4, which consisted of only a lower ability band and so was excluded from this analysis. The other schools all had two distinct ability bands of students at each year level. There was an upper ability and a middle ability band class selected from each year level, Year 9 and Year 10. Hence the total population of the sample used in this analysis was 294 with each year level ability band coming from three classes.

The results follow in Tables 5.2, 5.3, 5.5 and Figures 5.2, 5.3, 5.5 with a summary Table 5.6 and then the discussion of the results.

Table 5.2
Gender: Year 9 Middle Band

Attitude scale	Females (Scale mean)	Males (Scale mean)	Difference	t
Social Implications of Science	3.13	3.39	-0.26	-2.01*
Normality of Scientists	3.40	3.40	0.00	0.00
Attitude to Scientific Inquiry	3.54	3.78	-0.24	-1.48
Adoption of Scientific Attitudes	3.55	3.50	-0.05	-1.08
*Enjoyment of Science Lessons	2.77	3.25	-0.48	-2.33*
Leisure Interest in Science	2.24	2.48	-0.24	-1.30
Career Interest in Science	2.63	2.72	-0.09	-0.58
*p<0.05	n=31	n=34		

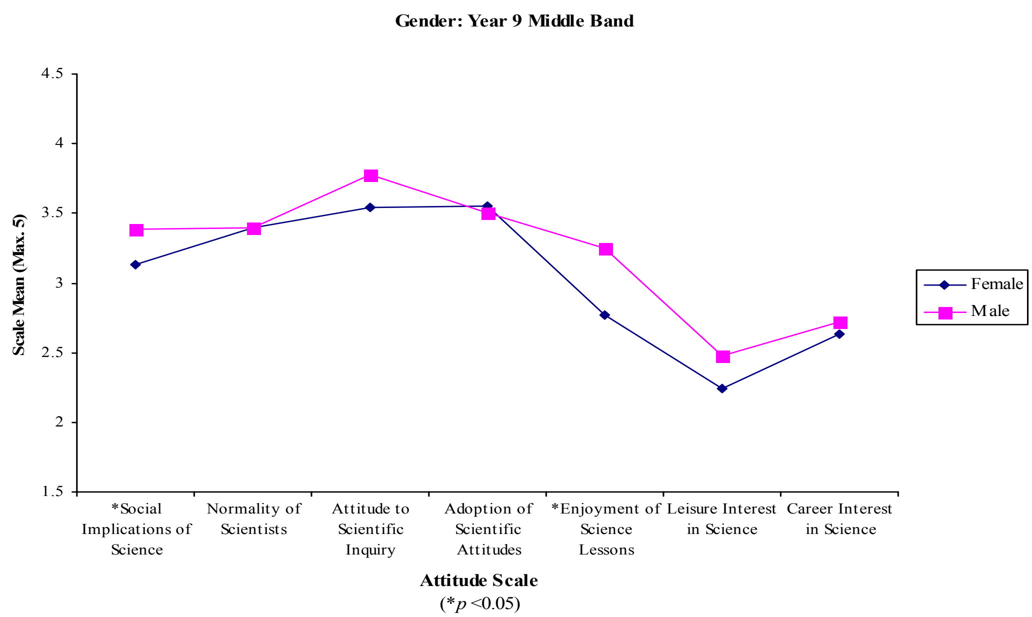


Figure 5.2. Gender: Year 9 middle band.

Table 5.3
Gender: Year 9 Upper Band

Attitude scale	Females (Scale mean)	Males (Scale mean)	Difference	t
Social Implications of Science	3.40	3.26	0.14	1.12
*Normality of Scientists	3.61	3.33	0.28	2.76*
Attitude to Scientific Inquiry	3.79	3.74	0.05	0.34
*Adoption of Scientific Attitudes	3.50	3.24	0.26	2.52*
Enjoyment of Science Lessons	2.96	3.01	-0.05	-0.31
*Leisure Interest in Science	2.33	2.67	-0.34	-2.13*
Career Interest in Science	2.40	2.57	-0.17	-1.70
*$p<0.05$	n=43	n=40		

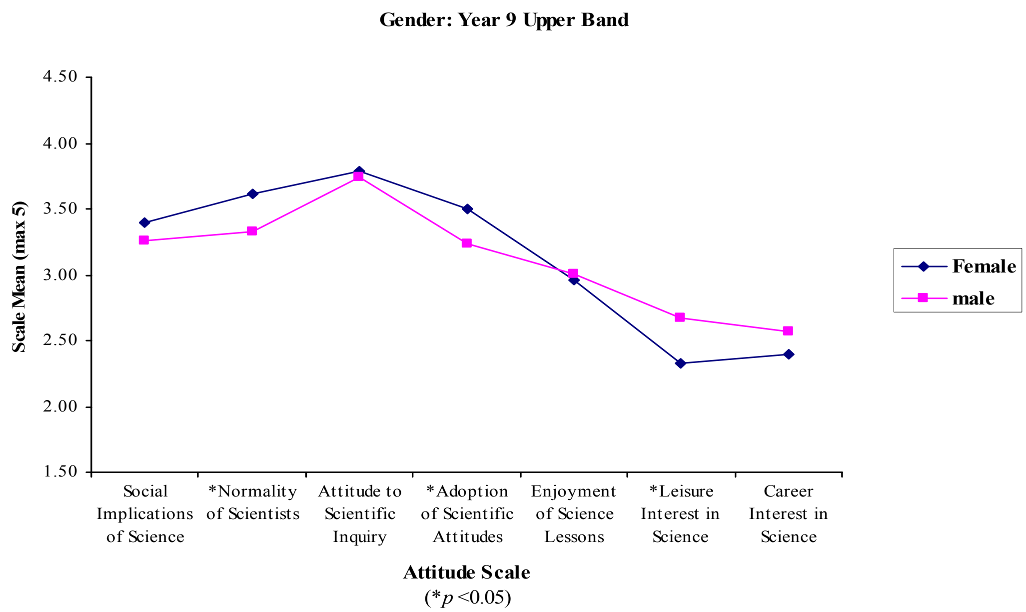


Figure 5.3. Gender: Year 9 upper band.

Table 5.4
Gender: Year 10 Middle Band

Attitude scale	Females (Scale mean)	Males (Scale mean)	Difference	t
Social Implications of Science	3.27	3.15	0.12	0.86
*Normality of Scientists	3.58	3.31	0.29	2.05*
Attitude to Scientific Inquiry	3.85	3.82	0.03	0.20
Adoption of Scientific Attitudes	3.42	3.32	0.10	0.68
Enjoyment of Science Lessons	2.91	2.96	-0.05	-0.20
*Leisure Interest in Science	2.13	2.55	-0.42	-2.25*
Career Interest in Science	2.48	2.66	-0.18	-0.95
*p<0.05	n=23	n=41		

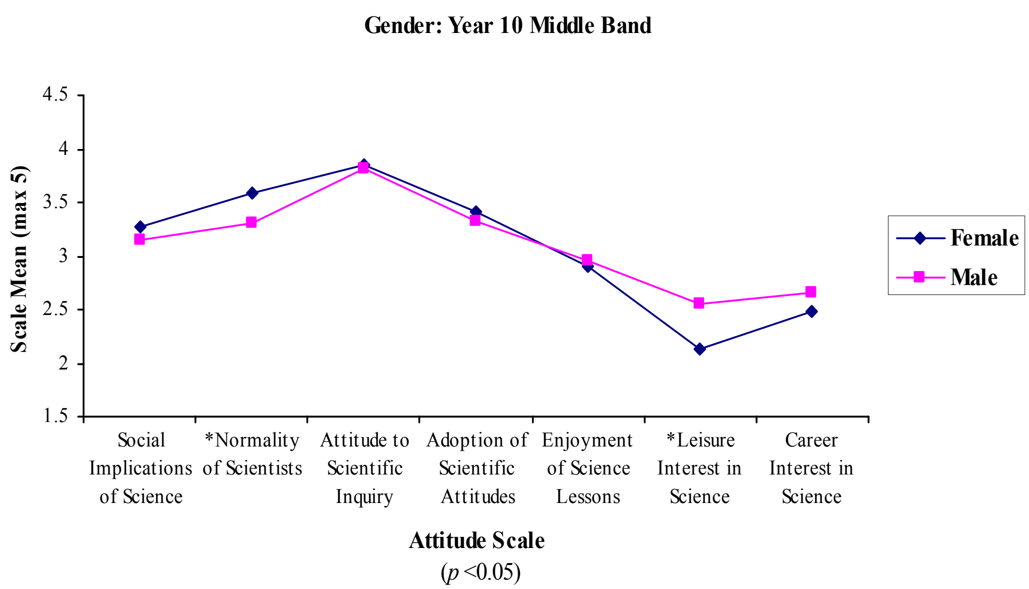


Figure 5.4. Gender: Year 10 middle band.

Table 5.5
Gender: Year 10 Upper Band

Attitude scale	Females (Scale mean)	Males (Scale mean)	Difference	t
Social Implications of Science	3.26	-3.33	0.07	-0.56
Normality of Scientists	3.52	3.40	0.12	0.95
Attitude to Scientific Inquiry	3.66	-3.95	0.29	-1.80
Adoption of Scientific Attitudes	3.50	3.50	0.00	0.02
Enjoyment of Science Lessons	2.78	-3.05	0.27	-1.49
Leisure Interest in Science	2.40	-2.57	0.17	-0.92
Career Interest in Science	2.78	-2.87	0.09	-0.52
No significant differences	n=43	n=39		

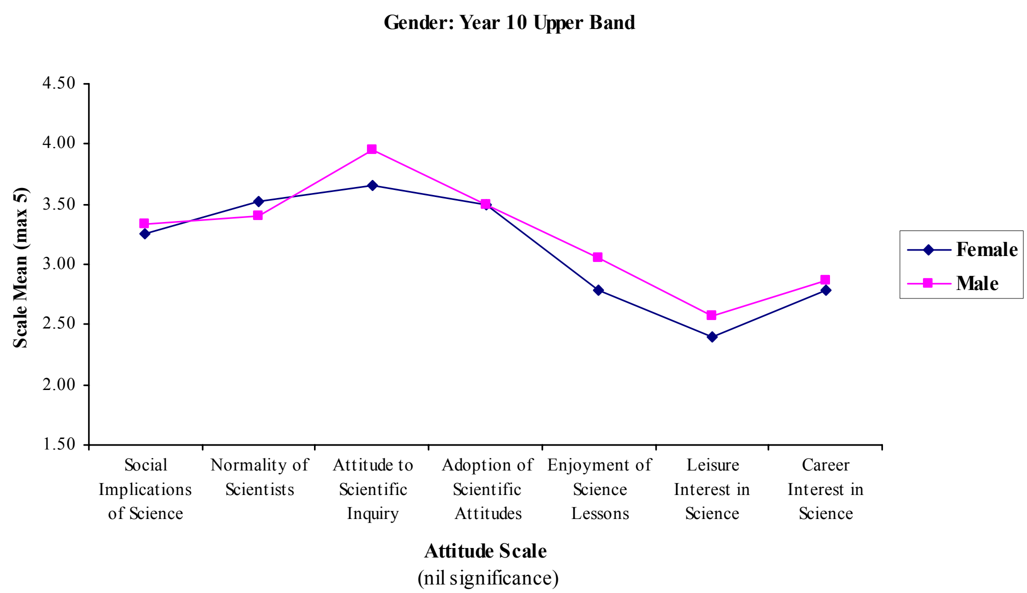


Figure 5.5. Gender: Year 10 upper band.

Table 5.6
Summary of Gender Differences for Years and Bands: Year and Band Data

Attitude Scale	Y9 Middle	Y9 Upper	Y10 Middle	Y10 Upper	All Students
Social Implications of Science	$p<0.05$ Males				
Normality of Scientists		$p<0.01$ Females	$p<0.05$ Females		$p<0.05$ Females
Attitude to Scientific Inquiry					
Adoption of Scientific Attitudes		$p<0.05$ Males			
Enjoyment of Science Lessons	$p<0.05$ Males				$p<0.05$ Males
Leisure Interest in Science		$p<0.05$ Males	$p<0.05$ Males		$p<0.01$ Males
Career Interest in Science					
	n=65	n=83	n=64	n=82	n=294

Discussion of results: Summary of gender differences for Years and Bands

There are some consistent threads running through the gender differences at different levels. The upper band Year 9 girls (Table 5.3 and Figure 5.3) and middle Year 10 girls (Table 5.4 and fig. 5.4) exhibit significantly higher scores for the Normality of Scientists attitude ($p<0.01$ and $p<0.05$, respectively) when compared with boys. As mentioned earlier this may in part be due to the boys preoccupation with scientists being people who make bombs and other such destructive devices. It should be noted, however, that by the time upper Year 10 (Table 5.5 and Figure 5.5) is reached this gap is considerably reduced with the boys thinking more about such sweeping statements.

As Fraser (1981a) reported there are highest scale inter-correlations between Enjoyment of Science Lessons and Leisure Interest in Science and Career Interest in Science. This trend in the relative leisure interest of boys and girls as they go through the junior school can be related to the findings of Baker and Leary (1995). They reported in their study that Year 9 girls in general liked science but in fact thought that their friends would not support the idea of a career (and hence leisure interest) in science. By the time they are going into Year 11 this trend is reversed with their friends supportive of science as a career. This helps to explain the lack of any significant differences at the upper band of Year 10 where the more able and mature students think more this way.

There is quite a marked difference between the students at each of the bands at Year 9. The middle band boys (Table 5.2 and Figure 5.2) showed significant differences ($p<0.05$) in the scales Social Implications of Science and Enjoyment of Science Lessons. This is probably due to the interest in hands-on work in science and the observation by the researcher that boys tend to be the 'doers' during the initial years at secondary school, especially in the mixed ability classes where girls often tend to 'stand back' because they tend to have less confidence in the laboratory in general (see Chapter 6). Research by Okebukola (1986) on the effects of cooperative learning on the attitudes of students towards laboratory work found that there was a significant difference in gender with the boys having more positive attitudes than girls for both the cooperative and non-cooperative learning groups. This is probably because of differences in earlier experiences reported earlier in this chapter. The significant difference in the Social Implications of Science ($p<0.05$) reflects the observations by Kahle and Lakes (1983) that boys indicated that they had read more science articles and watched more science related television shows than had the girls and would hence consider the social implications more.

At the upper Year 9 level the boys show a significant difference ($p<0.05$) in the Adoption of Scientific Attitudes and this perhaps reflects the experiences they have had through their formative years and that they are in the top band. The relative improvement of the girls in the upper band of Year 10 (Table 5.5 and Figure 5.5) is shown by the fact that the girls have now improved in this aspect when compared with the boys both exhibiting exactly the same mean scale score of 3.5. This is similarily consistent right throughout the entire upper band of Year 10 where there are no significant differences between the attitudes of males and females.

5.2.3 Gender and Attitudes: School, Year and Band

Science related-attitudes and gender were compared between classes at each of the three schools for the same year level and band. The range of classes analysed is outlined in Table 5.7.

Table 5.7
Gender Comparisons: School, Year and Band

Year	**Ability Band**	**School: Teacher of the class (years experience)**			**Figure**
		School 1	School 2	School 3	
9	Middle	1 (Mike <2y)	2 (Truby >15y)	3 (Barbara <5y)	5.6
9	Upper	1 (Mike <2y)	2 (Sandra <5y)	3 (Linda <2y)	5.7
10	Middle	1 (Brian >15y)	2 (Sandra <5y)	3 (Tuk <15y)	5.8
10	Upper	1 (Brian >15y)	2 (Truby >15y)	3 (Ken >15y)	5.9

The teacher profiles for gender and experience teaching are listed in the summary Table 5.20. In this section the discussion of the three schools at a particular band and year level can be found at the end of the three tables and plots of the results.

Gender: Year 9 middle ability band classes for Schools 1, 2, 3

The data for this year level and band are presented in Tables 5.8, 5.9, 5.10 and Figures 5.6.1, 5.6.2 and 5.6.3. This is then followed by a discussion of the results.

School 1

Table 5.8
Gender: Year 9 Middle Band School 1

Year 9 Middle Band School 1 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.25	3.53	-0.28	-1.07
Normality of Scientists	3.28	3.64	-0.36	-1.34
Attitude to Scientific Inquiry	3.28	3.61	-0.33	-1.019
Adoption of Scientific Attitudes	3.16	3.58	-0.42	-1.54
Enjoyment of Science Lessons	2.80	3.13	-0.33	-0.91
Leisure Interest in Science	2.42	2.72	-0.30	-2.21
Career Interest in Science	2.59	2.78	-0.19	-0.68
(nil significance)	n=11	n=12		

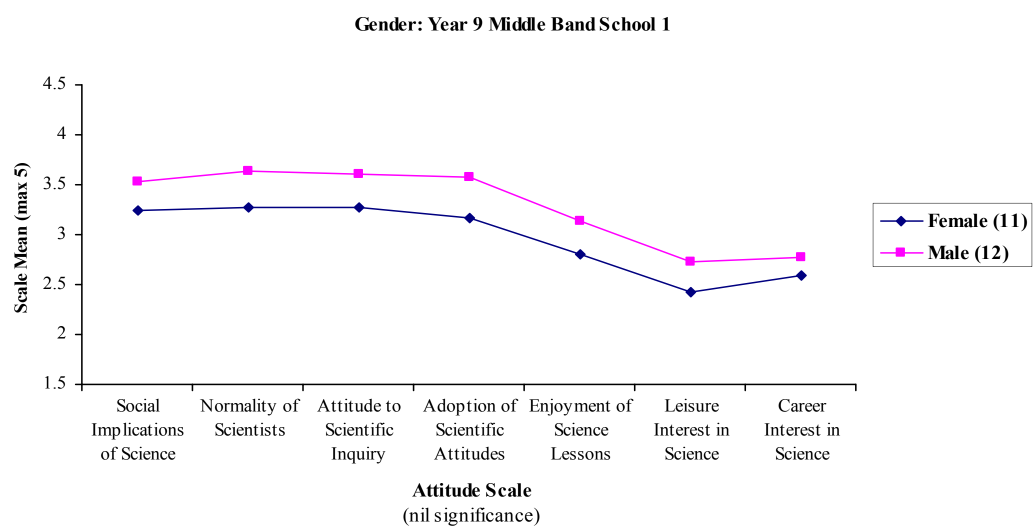


Figure 5.6.1. Gender: School 1 Year 9 middle band (Mike <2y).

School 2

Table 5.9

Gender: Year 9 Middle Band School 2

Year 9 Middle Band School 2 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.17	3.15	0.02	0.10
Normality of Scientists	3.56	3.32	0.24	0.87
Attitude to Scientific Inquiry	3.67	3.80	-0.13	-0.51
Adoption of Scientific Attitudes	3.90	3.35	0.55	0.18
Enjoyment of Science Lessons	2.38	2.87	-0.49	-0.144
Leisure Interest in Science	1.79	2.46	-0.33	-2.95
Career Interest in Science	2.26	2.86	-0.60	-2.03
(nil significance)	n=9	n=11		

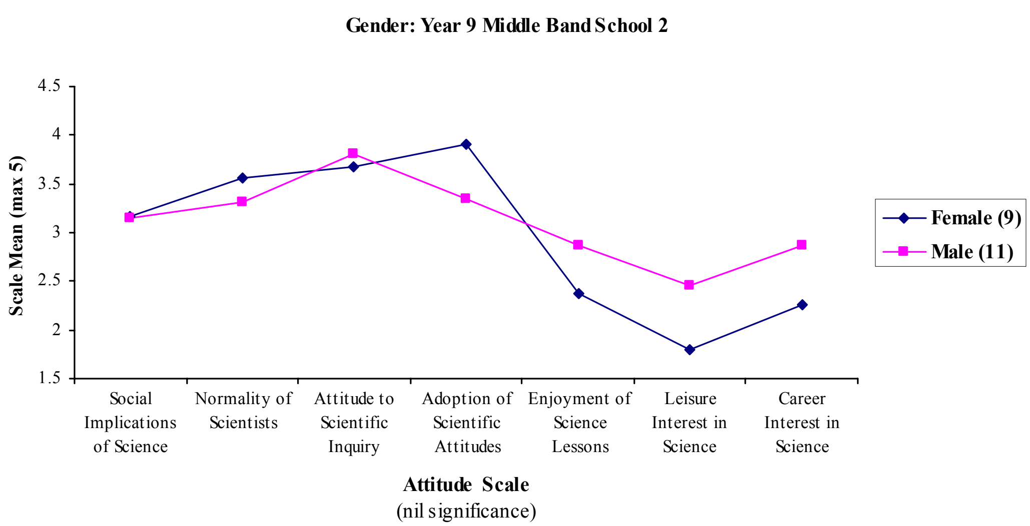


Figure 5.6.2. Gender: School 2 Year 9 middle band (Truby >15y).

School 3

Table 5.10
Gender: Year 9 Middle Band School 3

Year 9 Middle Band School 3 Attitude Scale	Females (Scale mean)	Males (Scale mean)	Difference	t
*Social Implications of Science	3.00	3.50	-0.50	-2.77*
Normality of Scientists	3.40	3.23	0.27	0.72
Attitude to Scientific Inquiry	3.68	3.95	-0.27	-0.99
Adoption of Scientific Attitudes	3.51	3.56	-0.05	-0.19
*Enjoyment of Science Lessons	3.05	3.77	-0.72	-2.21*
Leisure Interest in Science	2.42	2.24	0.18	0.58
Career Interest in Science	2.95	2.52	0.43	1.49
(*$p<0.05$)	n=11	n=11		

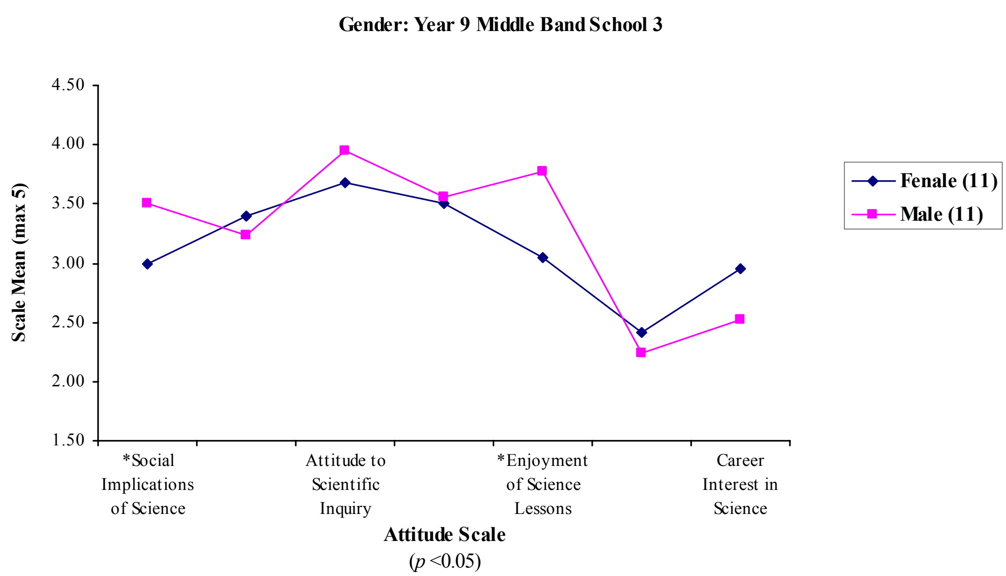


Figure 5.6.3. Gender: School 3 Year 9 middle band (Barbara <5y).

Discussion of results: Year 9 Middle Band Schools 1, 2, 3

On comparison of these equivalent (middle band) classes at Year 9 (Tables 5.8, 5.9, 5.10 and Figures 5.6.1, 5.6.2, 5.6.3) it can be seen that the science-related attitudes of the boys and girls are similar with the exception of the boys showing more Enjoyment of Science Lessons than the girls. However, the only statistically significant variation is found in School 3. A young teacher, Barbara taught this class while School 1 had another young teacher, Mike, School 2 had the more experienced teacher, Truby. The pattern for the rest of the attitudes is similar with the exception of School 2. The researcher made observations in these classrooms and noted that the teachers had differing styles. Barbara had her groups very well organised, especially in practical work, where the students knew who was allocated to each of the jobs as equipment manager, technician and recorder. The boys in particular seemed to enjoy this because they were usually far less organised than the girls, which may account for the higher scores for the Enjoyment of Science Lessons attitude. Truby's class was run in a very traditional manner and students respected what was being done and simply worked well in their groups while Mike, a very enthusiastic second-year teacher, tried hard to enthuse his students. All of the students seemed to enjoy being in his class and the boys and girls operated in a similar fashion during practical work.

Gender: Year 9 upper ability band classes for Schools 1, 2, 3

The data for this year level and band are presented in Tables 5.11, 5.12, 5.13 and Figures 5.7.1, 5.7.2, and 5.7.3. This is then followed by a discussion of the results.

School 1

Table 5.11
Gender: Year 9 Upper Band School 1

Year 9 Upper Band School 1 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.41	3.19	0.22	1.05
**Normality of Scientists	3.73	2.93	0.80	3.79**
*Attitude to Scientific Inquiry	3.83	3.41	0.42	2.09*
*Adoption of Scientific Attitudes	3.49	2.95	0.54	2.80*
Enjoyment of Science Lessons	2.94	2.94	0.00	0.00
Leisure Interest in Science	2.40	2.86	-0.46	-1.69
Career Interest in Science	2.84	2.93	-0.09	-0.41
(*p<0.05**p<0.01)	n=14	n=12		

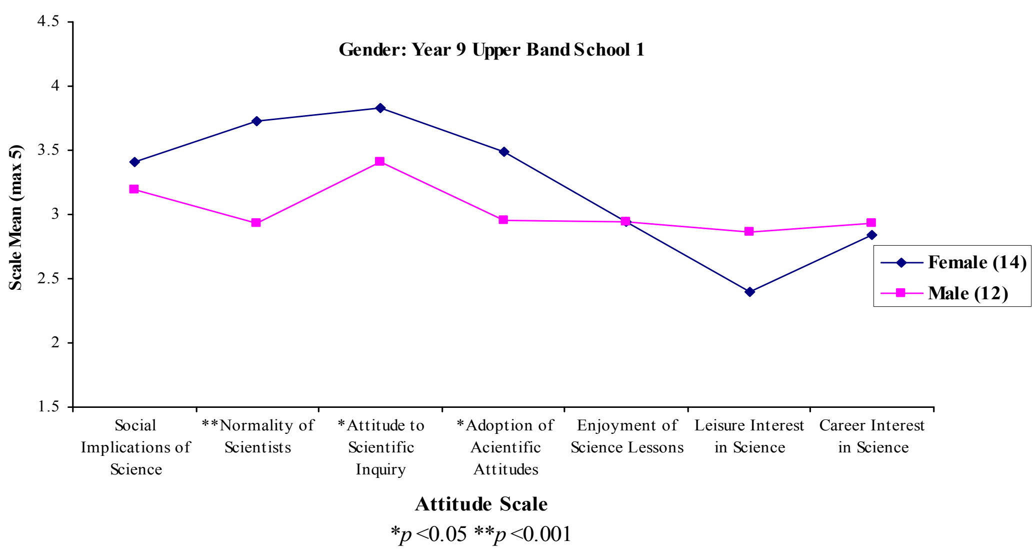


Figure 5.7.1. Gender: School 1 Year 9 upper ability band (Mike <2y).

School 2

Table 5.12
Gender: Year 9 Upper Band School 2

Year 9 Upper Band School 2 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.31	3.56	-0.25	-1.13
Normality of Scientists	3.47	3.54	-0.07	-0.43
Attitude to Scientific Inquiry	3.70	4.01	-0.31	-1.07
Adoption of Scientific Attitudes	3.39	3.47	-0.08	-0.45
*Enjoyment of Science Lessons	2.50	3.31	-0.81	-2.29*
Leisure Interest in Science	2.19	2.65	-0.46	-1.53
Career Interest in Science	2.64	3.11	-0.47	-1.90
(*p<0.05)	n=15	n=15		

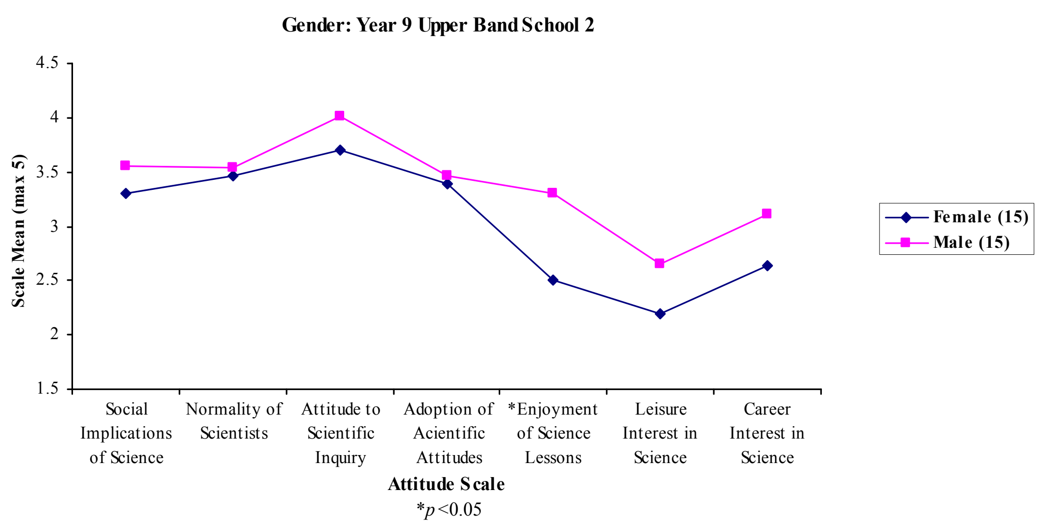


Figure 5.7.2. Gender: School 2 Year 9 upper ability band (Sandra <5y).

School 3

Table 5.13
Gender: Year 9 Upper Band School 3

Year 9 Upper Band School 3 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
*Social Implications of Science	3.51	2.98	0.53	2.41*
Normality of Scientists	3.66	3.35	0.31	1.59
Attitude to Scientific Inquiry	3.81	3.74	0.07	0.34
*Adoption of Scientific Attitudes	3.62	3.24	0.38	3.02*
*Enjoyment of Science Lessons	2.53	3.31	0.78	2.64*
Leisure Interest in Science	2.42	2.50	-0.08	-0.35
Career Interest in Science	2.96	3.01	0.05	0.30
(*p<0.05)	n=14	n=13		

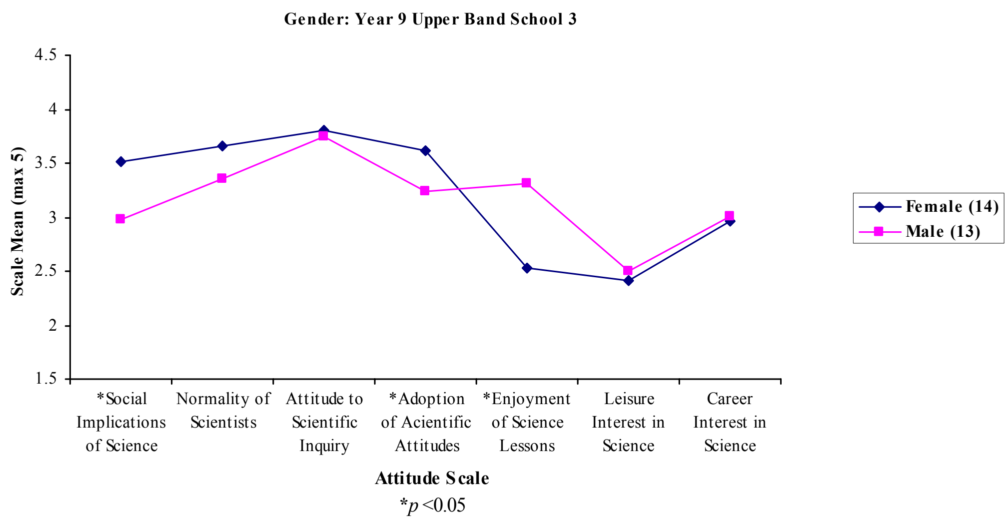


Figure 5.7.3. Gender: School 3 Year 9 upper ability band (Linda <2y).

Discussion of results: Year 9 Upper Band Schools 1, 2, 3

When comparisons of students in the upper band of Year 9 (Tables 5.11, 5.12, 5.13 and Figures 5.7.1, 5.7.2, 5.7.3) are made it can be seen that there are some statistically significant differences. All of these teachers are young and in their first five years of teaching. Mike is an enthusiastic male early in his teaching career and is well organised. The girls in his class showed significantly significant positive attitudes towards the Normality of Scientists ($p<0.001$), Attitude to Scientific Enquiry ($p<0.05$) and Adoption of Scientific Attitudes when compared with the boys of this class. In the classes of the two young female teachers (Sandra and Linda), the attitudes of the girls and the boys for these scales are essentially the same. In New Zealand as with many other countries students experience very few science teachers during their pre secondary school days and most of their teachers are in fact female. This could mean that Mike is one of the first male scientists the girls have experienced. The boys may simply see him as 'another guy'.

On the enjoyment scale the roles are reversed, however, with the boys showing considerably more enjoyment of science in Linda and Sandra's classes ($p<0.05$). The boys enjoyed being in Sandra and Linda's classes where the teaching styles of are different from those of Mike. Sandra and Linda were both more structured and precise in their set up of classes for laboratory work and the boys seem to find that this is easier and a better experience for them (according to both Sandra and Linda). Some of the qualitative data collected by Ferguson and Fraser (1998) suggested that boys were more concerned about the equipment and facilities and the types of experiences supports this to a certain extent.

Gender: Year 10 middle ability band classes for Schools 1, 2, 3

The data for this year level and band are presented in Tables 5.13, 5.15, 5.16 and Figures 5.8.1, 5.8.2 and 5.8.3. This is then followed by a discussion of the results.

School 1

Table 5.14
Gender: Year 10 Middle Band School 1

Year 10 Middle Band School 1 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.43	3.31	0.12	0.63
*Normality of Scientists	3.75	3.28	0.47	2.98*
Attitude to Scientific Inquiry	3.93	3.94	-0.01	-0.06
Adoption of Scientific Attitudes	3.59	3.29	0.20	1.26
Enjoyment of Science Lessons	3.44	3.09	0.35	1.42
Leisure Interest in Science	2.32	2.29	0.03	0.09
Career Interest in Science	2.69	2.48	0.19	0.64
(*$p<0.05$)	n=8	n=14		

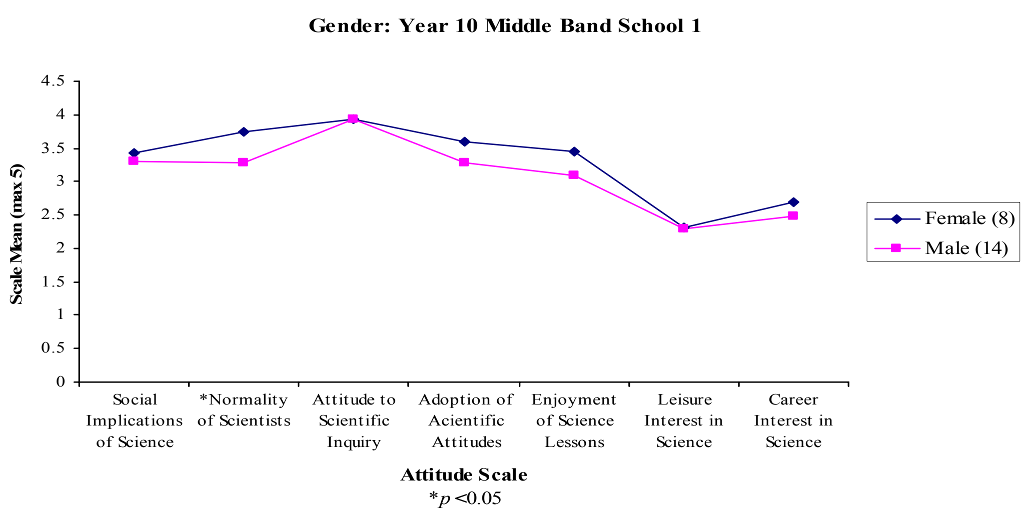


Figure 5.8.1. Gender: School 1 Year 10 middle ability band (Brian >15y).

School 2

Table 5.15
Gender: Year 10 Middle Band School 2

Year 10 Middle Band School 2 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.21	2.83	0.38	1.40
*Normality of Scientists	3.69	3.01	0.68	3.30*
Attitude to Scientific Inquiry	3.66	3.43	0.23	0.92
Adoption of Scientific Attitudes	3.47	3.19	0.28	1.07
Enjoyment of Science Lessons	2.48	2.67	-0.19	-0.39
*Leisure Interest in Science	2.00	2.88	-0.88	-2.53*
Career Interest in Science	2.52	2.69	-0.17	-0.63
(*$p<0.05$)	n=7	n=14		

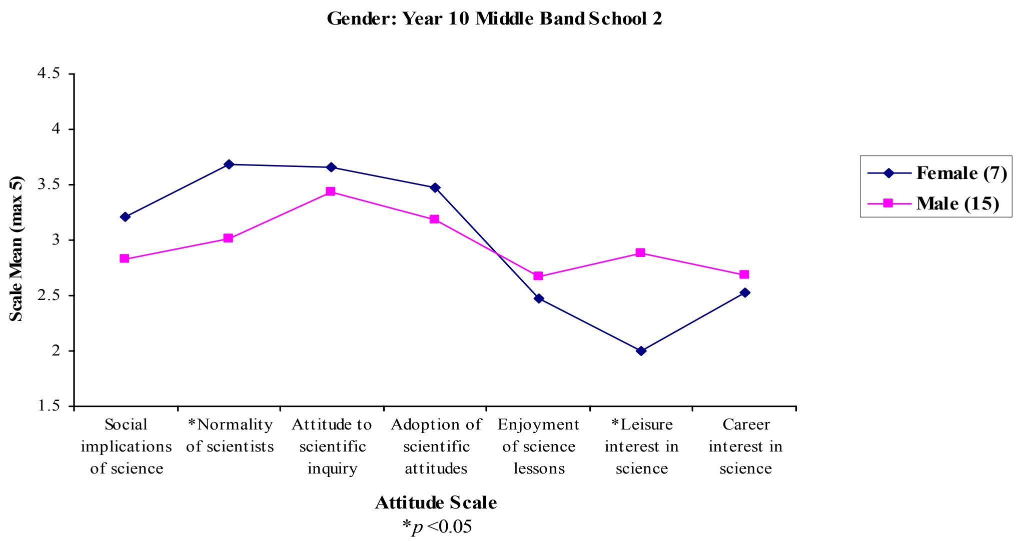


Figure 5.8.2. Gender: School 2 Year 10 middle ability band (Sandra <5y).

School 3

Table 5.16
Gender: Year 10 Middle Band School 3

Year 10 Middle Band School 3 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social implications of science	3.18	3.37	-0.19	-0.65
Social Implications of Science	3.31	3.73	-0.44	-1.57
Normality of Scientists	3.95	4.16	-0.21	-0.72
Attitude to Scientific Inquiry	3.21	3.52	-0.31	-0.98
Adoption of Scientific Attitudes	2.76	3.18	-0.42	-1.05
Enjoyment of Science Lessons	2.04	2.44	-0.40	-1.10
Leisure Interest in Science	2.25	2.84	0.69	-1.49
(*p<0.05)	n=8	n=12		

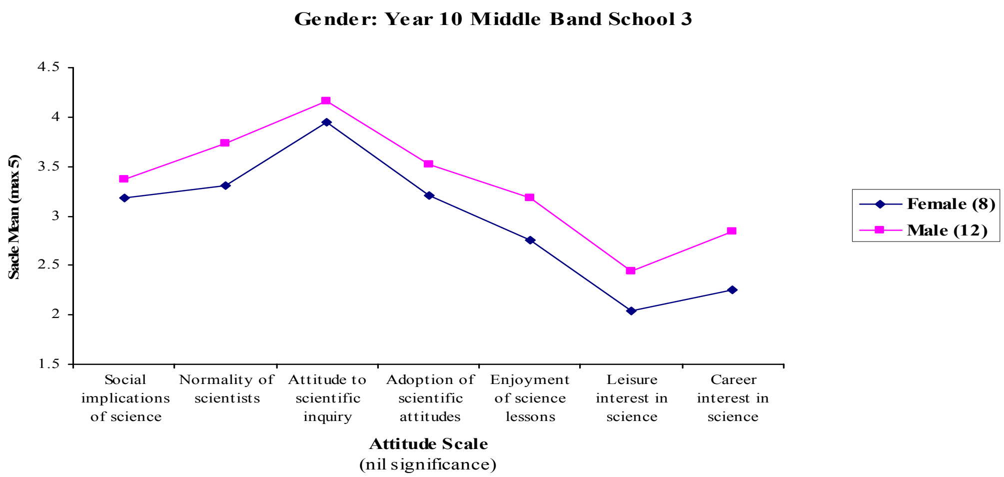


Figure 5.8.3. Gender: School 3 Year 10 middle ability band (Tuk >15y).

Discussion of results: Year 10 Middle Band Schools 1, 2, 3

A comparison between the students in the Year 10 middle ability band (Tables 5.13, 5.15, 5.16 and Figures 5.8.1, 5.8.2, 5.8.3) does reveal some significant differences. The teaching style of various teachers was established through observation and discussions with both the teachers and the head of department. Two experienced teachers, Brian and Tuk, teach in School 1 and 3 whereas Sandra, a young teacher, takes the college 2 class. The only statistically significant difference between the boys and girls in Brian's and Tuk's classes is for Brian where the girls score higher in the Normality of Scientists scale ($p<0.05$). Brian and Tuk are similar teachers in many ways, both running a more relaxed yet organised classroom environment using their experience to keep students on task. This approach appears to have a less polarizing effect on the boys and girls in their classes with the girls showing more positive attitudes towards the Normality of Scientists only in Brian's class. Sandra's teaching style, described previously, is organised and efficient and may have lead to the girls being more positive towards the Normality of Scientists and the boys showing a more positive attitude towards Leisure Interest in Science. On the occasions that the researcher observed this class Sandra did make use of anecdotal examples in her teaching, which may have influenced the boys' interest more than the girls. Johnson and Johnson (1987) and Kahle and Lakes (1983) suggest that boys of this age often tend to have more 'tinkering' experiences (playing with gadgets) outside the classroom than do girls.

The influence of the teacher and resulting classroom environment along with preconceived ideas students bring to school with them go some of the way to helping explain some of these gender attitude differences exhibited.

Gender: Year 10 upper ability band classes for Schools 1, 2, 3

The data for this year level and band are presented in Tables 5.17, 5.18, 5.19 and Figures 5.9.1, 5.9.2 and 5.9.3. This is then followed by a discussion of the results.

School 1

Table 5.17

Gender: Year 10 Upper Band School 1

Year 10 Upper Band School 1 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.14	3.35	-0.21	-0.92
Normality of Scientists	3.51	3.26	0.25	1.10
*Attitude to Scientific Inquiry	3.69	4.35	-0.76	-2.17*
Adoption of Scientific Attitudes	3.48	3.51	-0.03	-0.17
Enjoyment of Science Lessons	2.87	3.08	-0.21	-0.52
Leisure Interest in Science	2.06	2.62	-0.56	-1.92
Career Interest in Science	2.52	2.87	-0.35	-1.11
(*p<0.05)	n=14	n=15		

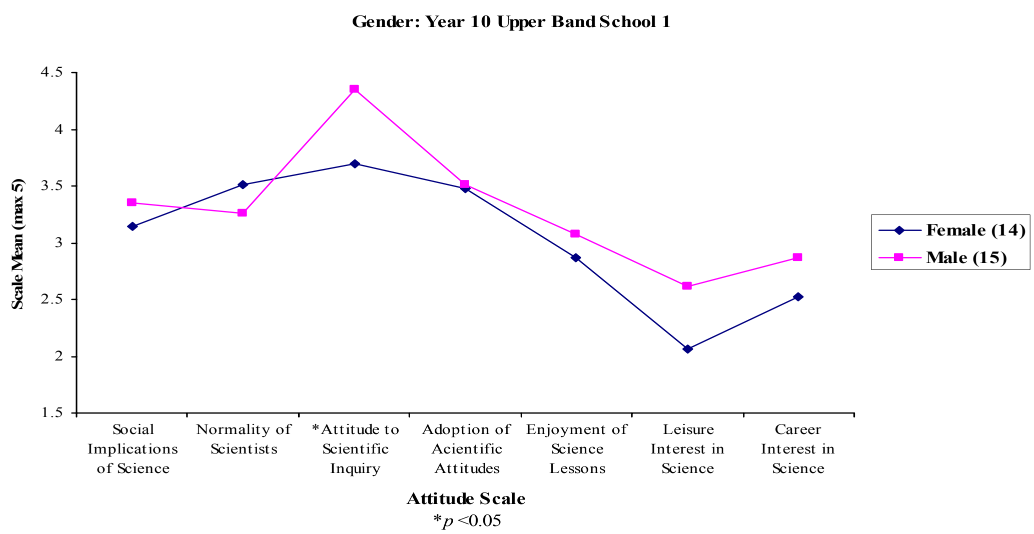


Figure 5.9.1. Gender: School 1 Year 10 upper ability band (Brian >15y).

School 2

Table 5.18
Gender: Year 10 Upper Band School 2

Year 10 Upper Band School 2 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.55	3.39	0.16	0.70
Normality of Scientists	3.88	3.65	0.23	1.23
Attitude to Scientific Inquiry	4.11	3.94	0.17	0.69
Adoption of Scientific Attitudes	3.75	3.64	-0.11	-0.64
Enjoyment of Science Lessons	2.74	2.97	-0.23	-0.77
Leisure Interest in Science	2.44	2.31	0.13	0.37
Career Interest in Science	2.81	2.68	0.13	0.35
(nil significance)	n=13	n=13		

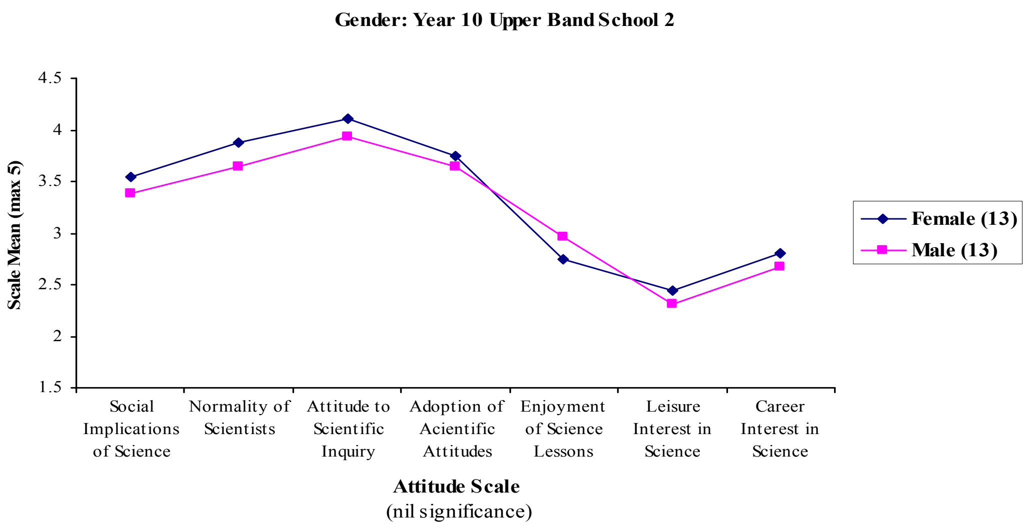


Figure 5.9.2. Gender: School 2 Year 10 upper ability band (Truby >15y).

School 3

Table 5.19
Gender: Year 10 Upper Band School 3

Year 10 Upper Band School 3 Attitude Scale	Females (Scale Mean)	Males (Scale Mean)	Difference	t
Social Implications of Science	3.15	3.24	-0.09	-0.47
Normality of Scientists	3.23	3.27	-0.04	-0.21
Attitude to Scientific Inquiry	3.26	3.41	-0.15	-0.77
Adoption of Scientific Attitudes	3.33	3.33	0.00	0.03
Enjoyment of Science Lessons	2.74	3.10	-0.36	-1.70
Leisure Interest in Science	2.67	2.79	-0.12	-0.54
Career Interest in Science	2.98	3.09	-0.11	-0.45
(nil significance)	n=16	n=11		

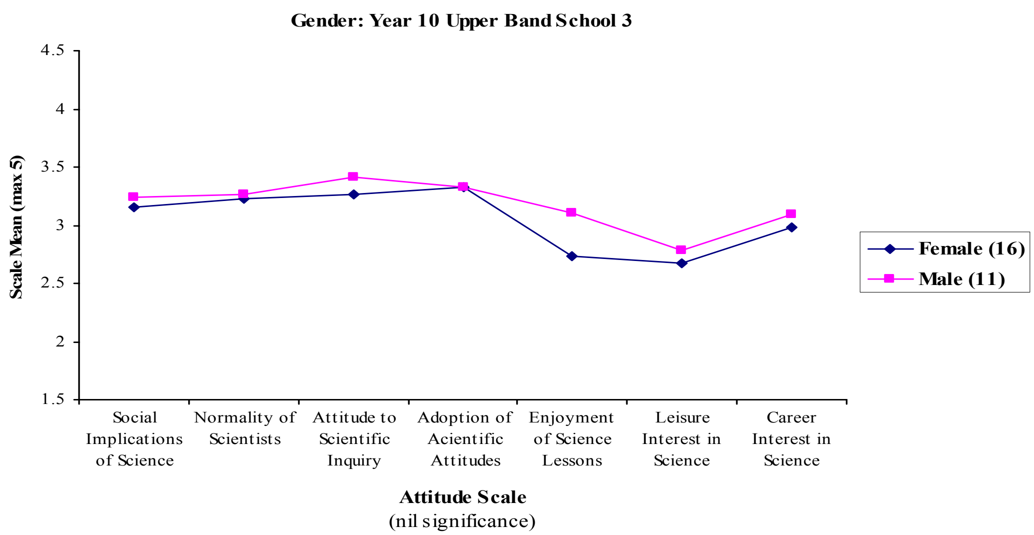


Figure 5.9.3. Gender: School 3 Year 10 upper ability band (Ken >15y).

Discussion of results: Year 10 Upper Band Schools 1, 2, 3

In the Year 10 upper band (Tables 5.17, 5.18, 5.19 and Figures 5.9.1, 5.9.2, 5.9.3) there is one statistically significant difference between the attitude scales of the boys and girls. This is for Brian's class at School 1, where the boys show statistically significant more positive Attitude to Scientific Enquiry ($p<0.05$) than do the girls. There is some difference noted in the Leisure Interest in Science attitude scale with the boys being more positive than the girls but this difference is not statistically significant ($p = 0.067$). The classes of Ken and Truby showed little variation in attitudes between the girls and the boys. Both Ken and Truby are traditional and efficient teachers while Brian is more relaxed with possibly a more friendly approachable manner towards his students. Such a manner may give the boys their more positive attitudes.

Overall, however, at this level of more able students at Year 10 there is little difference shown between the boys and the girls in their attitudes. In an analysis of gender differences in student attitudes towards science from the literature 1970 to 1991, Weinburgh (1995) noted that in general high performance students indicate a greater positive attitude for girls. This would close the gap normally seen for attitude scales such as the Enjoyment of Science where boys of lower ability were usually ahead.

Summary of gender attitude differences: school, year and ability band

Table 5.20
Summary of Gender Differences: School, Year and Band

Statistically significant variation: *t* test results

Year/ Band	School Teacher	Social Implications of Science	Normality of Scientists	Attitude to Scientific Inquiry	Adoption of Scientific Attitudes	Enjoyment of Science Lessons	Leisure Interest in Science	Career Interest in Science
Year 9 Middle	School 1 Mike							
	School 2 Truby							
	School 3 Barbara	$p<0.05$ Males				$p<0.05$ Males		
Year 9 Upper	School 1 Mike		$p<0.001$ Female	$p<0.05$ Female	$p<0.05$ Female			
	School 2 Sandra					$p<0.05$ Males		
	School 3 Linda	$p<0.05$ Female				$p<0.05$ Males		
Year 10 Middle	School 1 Brian		$p<0.05$ Female					
	School 2 Sandra		$p<0.05$ Female				$p<0.05$ Males	
	School 3 Tuk							
Year 10 Upper	School 1 Brian				$p<0.05$ Males			
	School 2 Truby							
	School 3 Ken							

n=294

Teachers:

Mike	Beginning teacher less than 2 years experience
Brian	Experienced teacher over 15 years
Truby	Experienced teacher over 15 years
Sandra	Less than 5 years experience
Barbara	Less than 5 years experience
Linda	Beginning teacher less than 2 years experience
Tuk	Experienced teacher over 15 years
Ken	Experienced teacher over 15 years
Sue	Experienced between 5 and 10 years

Table 5.20 above is a summary of the results of the application of the TOSRA across students from different year, band and school. Some general conclusions can be drawn from these results.

- The younger teachers seem to have a more polarizing effect on the students with more statistically significant differences in the attitudes of boys and girls.
- The girls show more positive attitudes towards the Normality of Scientists and at times Attitude to Scientific Enquiry
- The boys' showed more positive attitudes to Enjoyment of Science Lessons and Leisure Interest in Science (there is a correlation between these two attitudes).
- The boys only showed a significant difference in positive attitudes towards the Enjoyment of Science Lessons when taught by younger female teachers. This occurred in all three classes taught by young female teachers (of the 9 classes in the sample).

Discussion

Whereas a number of researchers such as Terwel, Brekelmans, Wubbels, and van den Eeden (1994) and Fisher, Fraser, and Rickards (1997) have noted that student gender may in fact influence learning environment perception there has been little research done on the relative influence of the teacher gender. The use of some of the classroom environment instruments such at the Questionnaire on Teacher Interaction (QTI) (Wubbels, Creton, & Hooymayers, 1985) could be valuable in determining how student attitudes reflect the relationship with the teacher.

5.2.4 Attitudes: Year Level Differences

Table 5.21

Attitudes: Year 9 and Year 10

Attitude Scale	Year 9 (Scale mean)	Year 10 (Scale mean)	Difference	t
Social Implications of Science	3.31	3.25	0.06	0.817
Normality of Scientists	3.44	3.44	0.00	-0.07
Attitude to Scientific Inquiry	3.72	3.81	-0.09	-1.18
Adoption of Scientific Attitudes	3.40	3.44	-0.04	-0.68
Enjoyment of Science Lessons	3.00	2.93	0.07	0.78
Leisure Interest in Science	2.44	2.44	0.00	-0.058
Career Interest in Science	2.81	2.72	0.09	1.02
n=148 n=146				

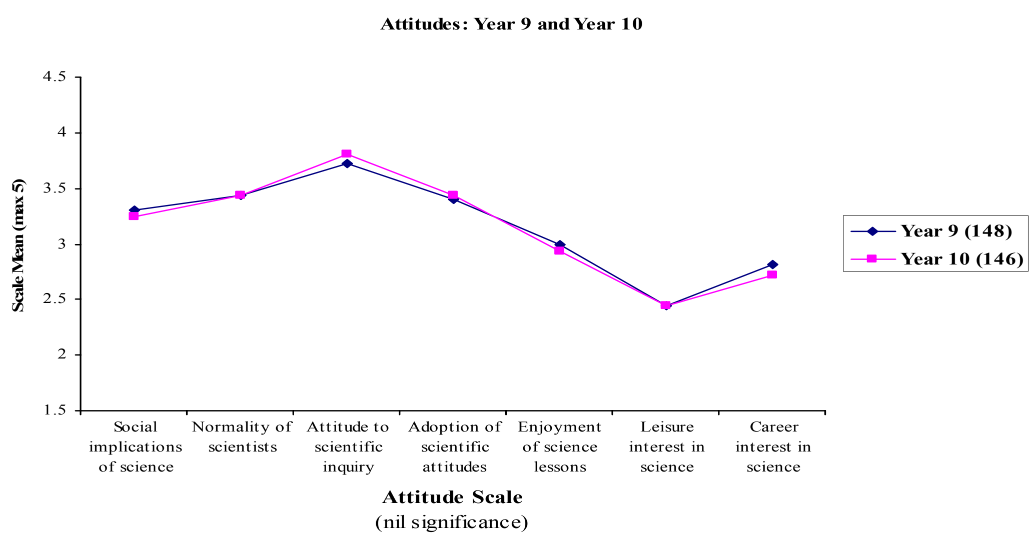


Figure 5.10. Attitudes: Year 9 and Year 10.

A comparison of all students in the study working at Year 9 and 10 (Table 5.21 and Figure 5.10) shows no statistically significant differences in attitudes towards science near the end of their respective years.

5.3 DISCUSSION OF THE ANALYSIS OF ATTITUDES TO SCIENCE

This chapter has investigated the use of the TOSRA in establishing any statistically significant differences in science related attitudes between students of different schools, year level, band and gender. The findings have illustrated some differences particularly with the gender of the students. The influence of student background, which is often difficult to change (if in fact it does need to be modified) within the confines of a science classroom for one hour a day, can still dominate. Research by Jones, Howe and Rua (2000) also showed that there continue to be significant gender differences in science experiences, attitudes and perceptions of science courses and careers and that boys and girls in their study and in fact everywhere are shaped by their culture. The out of school experiences available and selected by them are often simply an expression of the attitudes and values of the larger culture. However, girls who may not like science still choose to pursue science and, in a series of interviews carried out by Baker and Leary (1995) in the United States, girls did not like science and thought some of its applications were suspicious but they still liked 'real' science and some had plans to become a scientist who would 'do good'.

The current plight of boys (the fact that boys are being left behind academically by girls) in science in New Zealand has been well documented (Hassell, 1998) in the New Zealand media and some of the problems encountered by boys are undoubtedly contributed to by negative attitudes towards science.

The TOSRA has proved to be a useful instrument in the establishment of statistically significant differences in the attitudes of various groups of students towards science.

CHAPTER 6

THE EFFECT OF COOPERATIVE GROUP WORK AND ASSESSMENT ON THE ATTITUDES OF STUDENTS TOWARDS SCIENCE

6.1. OVERVIEW

The third objective of this study was ‘to determine the effect of a cooperative approach to learning and assessment on the attitudes of students to science’.

In the literature review there is a significant body of evidence that supports the effectiveness of students working in teams. Most of this research is focused on the cognitive outcomes of working in such teams. This study focused on the simplest possible group structure, one which the students enjoy being a part of, and one that was easy to establish. With a number of assessed tasks, such as tests, students gain a sense of purpose that helps to ensure they remain focused and enjoy working together towards achieving a common goal.

Also embedded in the literature are the changing views of education researchers on how important attitudes are and the fact that they have a major impact on student cognitive outcomes. There has been the development of a number of instruments for the measurement of these attitudes and that help provide the means to gather quantitative data on students and the effect of various classroom environments. Qualitative data gathered through the interview process and systematic observation form a significant part of the overall picture on attitudes. This chapter discusses attitudes and part of the effect of cooperative group work as a triangulation research process. The outcomes of the following investigations are reported within this chapter.

1. The results of TOSRA taken before the students embarked on their three-term cooperative learning programme and the results obtained immediately after this programme.

2. Student interviews after their work in cooperative learning teams.

3. Interviews with teachers about how they saw the students work during the course of the cooperative study. As with the students these were conducted in

late in the year, although there was some contact with them throughout the year.

These three views of the students' attitudes along with observations of lessons and assessments in the classroom both in person and by video analysis provided a good insight into the attitudes of the students participating in the study.

6.2 DATA COLLECTION WITH THE TOSRA

In Chapter 4 the instrument TOSRA validation information was provided for one of the first times in New Zealand conditions and after extensive trailing in Australia and the USA. The TOSRA proved to be an extremely reliable and valid instrument.

As outlined in the methodology, the TOSRA was administered to the students before (pre) they commenced their three-term course of cooperative group work and then again after (post). Three hundred and twenty six students from the four schools and 13 classes responded to the TOSRA during May and these numbers had declined to 312 by the time the second application of TOSRA was given in November. This was mainly due to students leaving the district with family commitments; often farming where farms in New Zealand change over during the winter season when the cows are dry.

The conditions in which the students sat the first test were repeated as closely as possible given the constraints of working within a secondary school. The following factors remained consistent for the applications of the pre- and post-tests.

- Time of the day. This could have a marked effect on students' such as their attention span and relative restlessness. For example, it was decided to avoid last period on Fridays.
- The relative help given to the students in reading the questions also remained consistent. The reading level of the TOSRA was found by the students to be

reasonable. However, on each administration of the TOSRA, the lower band of students at School 4 needed the questions to be read out and explained.

- The time to take the test remained within a 30 to 40 minute time span.
- On each occasion, the same teacher administered the TOSRA and recorded all relevant data on the envelope cover sheet.

A number of the students did ask about the fact the same question was often asked but in another way (reflecting the nature of the TOSRA having positive and negative items). The students were happy when the situation was explained to them and that they were not expected to think about changing their response to the reverse item.

There were only few 'invalid' TOSRA sheets handed in by students (ticking all the same column to save them reading and thinking about the response was the main example). The researcher later discarded these during the routine checking of papers for any anomalies that might exist and alter the nature of the responding sample.

6.3 RESULTS

6.3.1 Quantitative Results: TOSRA

The data collected from both the pre and post administrations of the TOSRA were analysed and the results are summarised in Table 6.1 below and also represented graphically in Figure 6.1.

Table 6.1
Pre- and Post-Test Means on TOSRA Scales

Attitude scale	Pre-Test		Post -Test	
	Mean	Standard deviation	Mean	Standard deviation
Social Implications of Science	3.32	0.56	3.27	0.58
Normality of Scientists	3.40	0.55	3.44	0.56
Attitude to Scientific Inquiry	3.79	0.65	3.77	0.68
Adoption of Scientific Attitudes	3.37	0.55	3.41	0.51
Enjoyment of Science Lessons	2.95	0.87	2.95	0.84
Leisure Interest in Science	2.71	0.78	2.43	0.78
Career Interest in Science	2.65	0.64	2.76	0.74
	n=326		n=312	

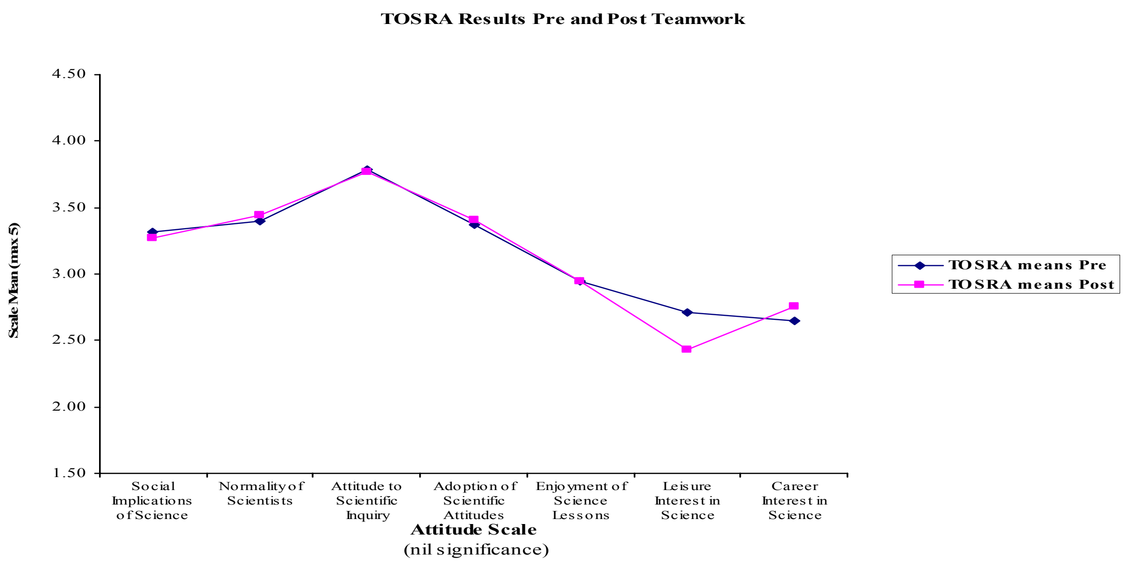


Figure 6.1. Plot of TOSRA results pre and post group work study.

As can be seen in table 6.1 and figure 6.1 there are no statistically significant changes in attitudes towards science between the two sampling periods. The *t* tests for paired samples showed there had been no changes within the sample over the time frame of the trial.

B. J. Fraser (2000) suggests that it is common for student attitude with this age group of students to decrease during their schooling hence no change in attitude is in effect an improvement on the norm and the figures can be looked at as encouraging. This is because the attitudes to science of these students typically decline over the school year. Work by researcher Greenfield (1997) at a cluster of three schools where boys and girls of various grades were both observed and surveyed using an abbreviated version of instruments on attitudes developed and validated by Mason and Kahle (1988) and Simpson and Troost (1982) concluded that younger students of this age grouping express more positive attitudes than the older students. Research by Yarrow, Millwater, & Fraser, B. J. (1997), and Ferguson and Fraser (1998) also support this assertion.

The study is perhaps not really a truly longitudinal study and such a study is required to investigate whether significant changes to attitudes with a group over time as measured by TOSRA occur.

6.3.2 Qualitative Results: Student Interviews

Introduction[1]

The protocol for the interviews is fully outlined in Chapter 3, but one of the key elements was having the students talk in a secure and comfortable environment. They were always given the question before a response was taped and this proved to be an important feature in the students' eyes. They often did not need any further clarification and generally warmed very well to the interview process as it proceeded. The researcher was impressed with the thought given by the students to their responses to the interview questions. The cohesiveness of many of the groups was apparent from the time they first sat down for the interview. While a few groups had an obvious leader, most of them were based on cooperative principles. The groups formed were almost entirely single sex because the students seemed happiest to work in this way.

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[1] *In the interests of student privacy all names given in the following transcripts are fictional*.

Student responses

Students were always given the opportunity to add to their responses if they felt a need to expand on their original comment. There were additional questions asked by the researcher if there was any particular feature of the group which he felt could be expanded on in order to better understand how they operated. The questions and responses have been grouped under three general headings to enable the students' comments to be interpreted.

Group functioning

These questions were asked to help to establish how the group operated on a day-to-day basis and if there were any major differences in the basic set up. Simple group operational factors such as the role of the individual during various tasks and whether the group had become hierarchical were asked. The issue of a potentially non-compliant group member was addressed and the students were asked how their group would have dealt with such a problem if it had arisen.

How did you first form your group?

Basically we're friends aren't we (Natasha).

Yeah, friends (Jodie).

Oh Mr. Smith let us choose our friends sort of thing (Sam).

Mainly all friends so decided that we'd go together as we usually hang around with each other at lunch times and during class (Mathias).

These were the common responses and all groups had in fact established themselves on the same basis. (Some teachers did try some composite groups later in the trial.)

Okay when you're doing practical or research assignments, how do you divide the jobs up?

Typical responses from the members of some groups were:

Each time we just go in a group and a different person goes up and gets the gear and then someone else will set it up (Steven).

We just do whatever we want to and argue about it if somebody wants to do the same thing, we just argue about it (Michelle).

Well we roster. But now we just kind of share it all around we don't have to have our own little jobs and stuff (Joe).

Well if say you're the technician you do the practical bit of it and the equipment manager gets all the gear and the reporter reports the results (Leah).

Changed every week, way that it's sorted into the group the jobs (Amie).

The majority of groups simply sorted out the jobs as they went along and changed this if they thought one person was doing the same thing all of the time. The only exceptions were the groups from one class whose teacher organised students on a weekly roster basis with assigned jobs such as, equipment manager, technician and reporter for practical work.

It may not have happened but what would happen if one of your team were slacking a bit, how would you encourage them to improve their work output?

Tell them to get their act together (Susan).

Hurry up and do something or just give them a hand and tell them what to do (Emily).

Well yeah we just tell them to get on with it and keep to the job (Hiku).

Give them a job that they enjoy and then they will keep going, get more motivated and stuff (Mia).

We do the fun jobs and we give them the…. of the harder jobs (Peter).

These responses were typical with most teams choosing to sort out any of these issues themselves to the satisfaction of their team members. Jobs such as who does the writing for a team during tests were, however, often assigned to the team member who was quick and wrote legibly although one group selected their scribe on her ability to best summarise the answer.

She's got the neatest writing and because Anne like knows how to write it down like we don't say things in a way it should be written down (Leah).

Has one person become the boss?

Typical responses from the members of some groups were:

Everyone works together (Mark).

No we don't have that sort of thing (Mathias).

No we all work our answers out together (Susan)

Not really all just work as team together (Amie).

There was only one team of the 14 interviewed that considered that they had a 'boss'; two others had mixed responses within the group.

The responses from the members of this group were:

Sonya (Toni).

Yes definitely Sonya (Michelle).

Overall, the day-to-day running of the teams was by consensus with the students working through any issues that should arise in a cooperative manner. Other advances included the fact that during assignments, groups with reluctant contributors (which was rare) developed strategies to ensure equal input. The students saw little need to elaborate on the simple straightforward answers to these questions.

Group dynamics and change

These questions helped to establish how the students have adapted to better functioning as a group over the duration of the trial. This also helped to determine how this has benefited them both as individuals and as a group and if in fact this sort of 'teamwork' have any application to the real world. These questions also give an indication of the attitudes of the students towards each other, themselves and their science.

If one member of the group has a different answer from the others during a test how do you sort that out and has that changed over the course of time? Has this changed over the course of the year?

Yes majority rules but we discuss and what's reasonable sort of (Jane).

We sort of discuss it all and see if what they've got to back up their answer and then you just find, see if they're right or not and back up the answer (Tiffany).

We usually do majority of the group but we've started to more, have like talk about between, try to prove your answers right to others (Linda).

We've got better at it as expressing our own opinions and more confidence and stuff in each other and ourselves (Jane).

It's like majority wins but if someone is really kind of dead set on it they try to explain it to others (Steven).

When we do the test if someone's got a different idea we all explain it and see what's just best. Yes we have got better at this (Jesse).

Yep. If they disagree we ask them how they got the answer and you work through it again (Shane).

To start with we, if most people thought the answer was right, write it down but then we talk it through more (Mathias).

This was generally the pattern with all of the groups; almost all the boys said they had changed the way their group operated during tests.

Do you think you will do better in the exams as a result of having worked in groups than you would have as individuals, in other words is group testing a learning exercise as well as just doing a test?

Yes I think we will do better in the exam if we've worked in groups because we've listened to each other (Natasha).

Yes and better ideas of the question and it's explained in the way that we can understand because it's between our age (Sandy).

I think we will; do better than we would because we've sort of learned as we've done the tests, doing with the group and other people's ideas (Mia).

Yes we probably will because we've learned from other members of our group and gained more from them as well, from what they've (John).

I think I will do better in the exam because we worked in groups because you're like remember things as Mike said…. came out and remember oh that's right (George).

I reckon we will (Mike)

These were typical answers for most of the groups with the boys generally being much briefer in their answers. There was only one group of girls who in general suggested that they would not do better in their groups. One of these girls (Ingrid) was a very able student who while she recognized the need to work with others she did not think it helped her grades.

My marks have essentially gone down. Like I was getting 82% and then like its going down to about 70 (Ingrid).

Not really (Wendy).

Especially with kids, we argue pretty much, it's like if I was doing the test I'd like you know what you're going to put down but like in a group discussion you have to sort of take into account the others ideas so you may lose, but even if you really think you know it you have to sort of take into consideration what other people will say (Ingrid again).

Does group or teamwork have any application to being in the workforce like working at McDonalds, working in a lab or working at an aircraft factory or the hospital?

Yeah you work in a team wherever you're going to work (Sonya).
Yes because in the workforce you have to learn to work with other people so it helps you get ready for that (Sarah).

Yes it teaches you how to work as a group that's a base skill at the end of the course (Jane).

The things that we're doing if…something it would be a lot easier in a group because you get more ideas, more feedback (Sam).

Gives you better people skills (Liam).

Oh yeah like job advertisements it always says must be able to work in a team or work well with others (Barry).

These responses were typical of most groups with some groups. The relevance of good teamwork was seen as important in the outside world.

Overall, the students did adapt very well to the group environment and virtually all of the groups showed considerable improvement and an appreciation of the skills that they had learned as members of their group. The students said that they discussed disputed answers more vigorously, rather than accepting the answer offered by the most able student. The vast majority saw definite benefits in their learning outcomes as individuals through their learning from their peers during group testing exercises in particular. There was a real appreciation of where the team skills fit into the workplace.

The benefits

These questions set out to establish the students' feelings about their experiences of working in cooperative teams and if they found the experience to be a positive one that they would like to continue. They were asked about various aspects of their work as a group member such as enjoyment, anxiety and stress levels when completing assessments.

If you were given the option of working in groups or as individuals for the next test what would you choose?

Groups because we get better results working together (Jane).

Probably in groups again I'd say (James).

The above responses were typical of the sample interviewed with most simply saying 'groups'..

Do you find science easier when you're working in groups?

Yes because it takes a lot of stress off you, you can all share the jobs around (Mathias).

Yeah it is easier because the groups can help you out if you don't understand a question or something like that (Mark).

All students responded in this way, the majority simply said 'yes'.

Do you find science more enjoyable working in groups?

Yes (Mark).

Yeah, more fun more fun doing tests (Joe).

It is and tests are the worst part and it's a bit better to do them in groups, they're a lot better (Mathias).

This was again the most common set of responses for this question, a small number of students made the comment the 'we can talk more' but this was not a usual response.

Summary of student interviews

There is strong evidence from these interviews that the students have certainly developed good cooperative techniques and skills along with a sense of enjoyment. This is evident from what they said about the establishment and organisation of their groups. They were also very aware of how they had changed the way their group operates in light of more experience working together for longer. The researcher noted the enthusiasm that emanated from many groups as they spoke about how they had improved on various aspects of cooperative work. The enjoyment they obtained from working together and achieving much better results showed how positive they were about this type of learning environment. One of the rare exceptions was a high-achieving female from one group who said that while she preferred to work on her own, she realised that she needed to learn to work with others in a group situation.

The gender of the groups did affect how they operated particularly at the start of their group work with the girls being much more cooperative early on than were the boys. The boys did say in many of the interviews, some of which have been reported previously, that they did improve the way that they worked together in tests especially with more group consultation occurring before just writing the answer (often submitted by the dominant male). The groups all had an appreciation of the wider implications of being a 'good team person' when they eventually leave school and go into the work force and this sort of experience is very useful training.

6.3.3 Qualitative Results: Teacher Interviews

Introduction[2]

The teacher interviews were usually conducted outside the school building and away from any distractions with which teachers so often have to deal. The questions were not structured but of the same basic theme ensuring that all of the key points were covered. Prompts were used if required to ensure that this occurred. The teacher's responses to questions about their students can be grouped but most of the interest centered on how the students performed in their formal tests although laboratory work and assignments were also mentioned.

Could you tell me how well the groups cooperated and what happened over the course of the study?

They really got on quite well, I sorted them into groups and I organised them into their groups, told them what they were going to do and told them it was the same test situation as far as they could talk within their groups but not between groups and they adhered to that really, really well, actually all year, I haven't had to clamp down on them at that point at all. And they just worked really well in the groups and as I came around they were all on task they were all contributing and in general I've got a really positive feeling about how the group tests have gone and I think I will definitely be using it in the future (Mike).

I've been really quite interested in this as it has worked far better than I thought it and before we got onto the trials. What really impressed me was when we were doing the first lots of tests how actually there was a real working atmosphere in the class and you give them individual work to do and they can be distracting each other and they can be sort of mucking around but I found that they got on, got with the task and they had really quite a sense of purpose about it (Brian).

Yeah they have, it's sort of I reckon there's more sort of interaction between them, at the start it was sort of a little bit the brightest person in the group doing their own

[2] *In the interests of teacher privacy all teacher names given in the following transcripts are fictional*.

thing basically and the others hanging off to the side whereas now they seem more willing to contribute (Truby).

I saw a lot of discussion going on but I didn't see that the stronger personalities were prevailing all the time, I found that it was quite often it might be a strong personality who put forward an answer and they would fight quite strongly for it but they'd always come to a group consensus and generally come up with the correct answer or a more sensible answer. So yeah I didn't see it as arguing at all I saw it as yeah on path discussion. I suppose more than any conflict going on at all (Sandra).

And as far as the marking goes I think it has been very consistent as to I think some of the lower marks probably have picked up but those who do well are still doing well and those who do poorly have been dragged up a little bit and they're possibly getting more enjoyment and more achievement out of science because of that but generally those students who do excel are still the same ones who are excelling now even, they've just dragged other people up with them I think. I don't think the bottom has dragged anyone down (Mike).

The comments of the teachers cited above suggest that they were very pleased and in fact surprised at how well the students took to the group testing in particular. They remained on task, focused and got better at genuine cooperative work as time went on. The evolutionary nature of the groups is reflected in the teachers' comments such as how the students learned to work through other possibilities for answers before committing them to paper. The improved interaction between the students was another pleasing aspect in their teachers' eyes.

How well have the students been motivated and enjoyed their work in groups?

You know; they seem keener because they know they're going to get better marks. Before the test they know they're going to get a reasonable mark… some of those kids by themselves they'd be doing pretty poorly (Mike).

Get a buzz too when they go through all their scoring and they're getting 20% more. They seem a bit more positive, pretty positive on it. The marks they're getting now are pretty good. One top class gets 80s and 90% for most of these groups. Whereas by themselves they would probably get below 65 or so I guess (Brian).

I've given them a couple of individual tests to get them on task for their 3rd form exam and it was all positive, they were all moaning when I said they were going to have an individual test again and they'd really enjoyed the experience of doing it in groups (Truby).

Teachers saw that the marks that the groups were able to achieve were in fact a significant motivational factor along with the enjoyment of actually working together on a group task.

Has this type of group work become a teaching tool?

Yeah what it seems to have done for me is that now in a test situation it's also becoming a learning situation as well I can wander around and if they're discussing things I can become involved in the discussion and they can bounce ideas off me and I can bounce ideas back off them sort of thing and say well what do you think about this or have you thought about this ideas. Yeah I think it becomes more another learning opportunity or there's learning going on in the classroom where in a normal test it's just stress going on in the classroom (Mike).

Yep well as I was saying you can get away with doing less marking or you can do more assessments with the same amount of marking (Brian)

These were typical responses from all of the teachers; essentially the ability to walk around the room and assist with problem solving approach and teach students how to answer questions without telling them the answers. It was pointed out during informal discussions with teachers that this was rarely done in a 'normal' testing situation. The reduction by a third in the marking load was also seen as an opportunity to undertake more formative assessment in teams 'since the kids enjoy it and learn at the same time' and still do less marking.

6.4 LONGITUDINAL CASE STUDY

6.4.1 Introduction

The researcher conducted a pilot study with a group of 31 Year 10 School 3 students in 1996 using cooperative teamwork and the TOSRA. This was part of the groundwork leading up to the design and carrying out of the full study in 1998. After the extensive study of 1998, the opportunity was taken to retest those students still at school remaining from the original pilot study group. Most were still doing science and showed a real interest in the work being done by the researcher. They were happy to do the TOSRA again and be interviewed about their experiences as juniors and in the ensuing years. This sample of students had a significant amount of cooperative group work in science during their time at School 3 (see Chapter 7 for the type of cooperative teamwork able to be undertaken by senior examination students).

6.4.2 Quantitative Results: TOSRA

The results of this small study do look promising although the number of students (n=13) in the study is too small to be statistically conclusive. It is of interest to note that many of this group had gone on to science related careers. These students stated that some of the TOSRA questions were specific to the classroom but they had answered them as well as they could but they said that they still took an interest in science and that things they learnt were useful to them. The figures were generated using the results of the TOSRA for the same 13 students (9 girls and 4 boys) in both samples. These results are summarised Table 6.2 and Figure 6.2

Table 6.2
Small Scale Longitudinal Study at School 3

Attitude Scale	6/8/96 Year10 Scale mean	19/11/99 Year13 Scale mean	t
Social Implications of Science	3.53	3.76	NS
**Normality of Scientists	3.53	4.12	*P*<0.001
Attitude to Scientific Inquiry	3.79	3.57	NS
Adoption of Scientific Attitudes	3.66	3.79	NS
Enjoyment of Science Lessons	2.85	3.14	NS
Leisure Interest in Science	2.31	2.91	*P*=0.06
Career Interest in Science	2.33	3.05	NS
	n=13	*n=13*	

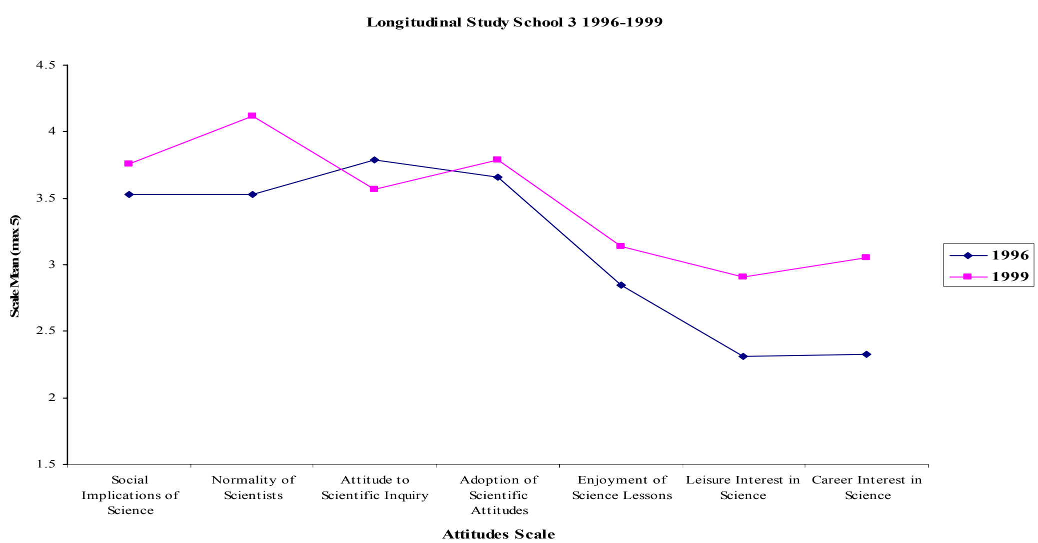

Figure 6.2. Small scale longitudinal study at School 3.

The number of students is small, therefore, these results should be treated with caution but they do show a marked improvement in a number of attitudes with significant *t* scores for the Normality of Scientists and very close to significant (*t*=0.06) for the Leisure Interest in Science, which tend to affect the career choices of students. The classroom-based attitudes of Attitude to Scientific Enquiry, Adoption of Scientific Attitudes and the Enjoyment of Science Lessons have remained at similar levels for this group of students. Overall these TOSRA results look most encouraging.

6.4.3 Qualitative Results: Student Interviews

Six of these students were interviewed in November of 1999 during their last weeks of school at School 3. The interview questions were not strictly scripted but they followed the same pattern for each interview session. General questions about whether or not they could actually remember working in teams as juniors led to more detail, such as the enjoyment they got from working in teams. They were then asked about whether they preferred working in teams to working as individuals and what affect this had on their stress levels and enjoyment of science. They were asked to comment on whether or not they had learned more as a result of this style of teaching and if it had any place in the 'real world'. They were also asked if the current Year 9 and Year 10 students should experience this style of learning, there was always the opportunity to discuss these ideas in more detail. The final question was about where they were going in the following year and what they intended doing. The students were interviewed individually except for one pair.

The results were of real interest with all of the students interviewed remembering their teamwork in the junior school. With the question of enjoyment, stress and learning the responses below of female 1 and male 1 were typical.

Can you remember whether you enjoyed doing it that way (the tests) or would you prefer to have done it as individuals?

Nah, I think the group thing coz you get help as a group and it's not too serious, it's a bit laid back, easy to learn (Melanie).

Yes, it's less stressful and it's easier, there's somebody around, you're more likely to get it, remember all of it (Daniel).

Do you think working in those groups has helped you now in any aspects of science, whether it is enjoyment or, carrying on with it or whatever?

I think I prefer to work in groups now I feel supported. Just coz it helps you understand more if you've got your friends and stuff to help (Melanie).

I'd have to go with that (Daniel).

On the question of learning, questioning the answers of others and peer support the following responses sum up the general feeling of this group of students.

Do you think you learn the syllabus better by talking to each other in that group in that test situation?

Yep, coz when you see a question on it you just think back to the big arguments you had on that, that's right (Linda).

And do you think the enjoyment part of it was worthwhile, what about the pressure on individual students to succeed, was that reduced? In your case you always succeeded anyway but how do you think it affected other students? (To Carol the school dux).

I think it's good because you learn more when someone else, a peer explains something to you. I think, yeah, people do better in a team situation (Carol).

Can you remember if you enjoyed that way or what are your memories of that sort of setup?

It was pretty good. It was different at the start coz we always used to do it singularly but I found especially with Carol she was new she could teach us the answers. If I didn't understand stuff like that the others would help explain it and that was always good and yeah, I found it quite good (Louise).

When they were asked about the relevance of teamwork to scientists working in the real world the responses certainly supported the concept of group work at school.

You mentioned working with each other, do you think it's important in today's scientific world in particular, working with other people?

Yep, definitely, coz I think any work in science today is people working in a team, it will be a team effort to achieve big things, so yep (Carol).

Looking back on working in groups that way, do you think that's got any implications in the real world?

Oh, absolutely, like I want to design and I'm sure that I'll have to work in groups to decide on how things should be designed, and yeah, listening to other people's point of views and things and coming to a decision from that always helps. Getting your ideas and coz you always solve problems like that and yep (Louise).

Overall these students were very positive about their experiences in the learning teams and saw them as useful as a learning tool, enjoyable and relevant to the world of science.

6.5 THE ATTITUDES OF LOWER BAND STUDENTS: SCHOOL 4

6.5.1 Introduction

This group of students was of particular interest as motivation of lower achieving students was a continuing concern for their teachers and parents. As outlined in the Chapter 3, there were few if any behavioral problems in this class but some students were of limited academic ability.

6.5.2 Quantitative Data

The students were read the questions in TOSRA and were able to ask questions if they needed help with any of the words or phrases. The same teacher administered the TOSRA on each of the occasions in April (term 1) and November (term 4) 1998. She is only identified as Sue and had close to 10 years of experience in the classroom teaching both at senior and junior level science.

The results are outlined below in Table 6.3 and Figure 6.3.

Table 6.3
TOSRA Results for the Year 10 Lower Band Class

Attitude scale	Pre: T1/1998 (Scale mean)	Post: T4 1998 (Scale mean)	Difference	*t*
Social Implications of Science	3.14	3.12	-0.02	NS
Normality of Scientists	3.25	3.47	0.22	NS
Attitude to Scientific Inquiry	3.75	3.92	0.17	NS
Adoption of Scientific Attitudes	3.51	3.26	-0.25	NS
Enjoyment of Science Lessons	2.42	2.68	0.26	NS
Leisure Interest in Science	2.12	2.24	0.12	NS
Career Interest in Science	2.51	2.44	-0.07	NS
	n=17	n=18		

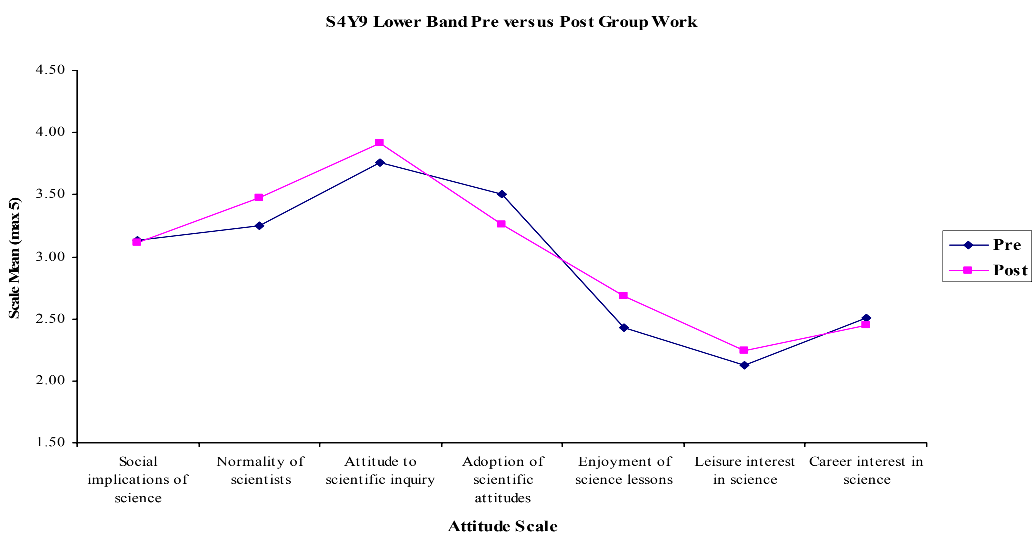

Figure 6.3. Plot of pre and post group work for Year10 lower band.

These results are of interest as they do show some positive movement in a few of the attitude scales but with no significant *t* scores. However, the small sample number of students (n=17) is too small to generalise too much but they certainly did not go down when this may be expected to be the case, again based on observation by many researchers such as such as Greenfield (1997), Mason and Kahle (1988) and Ferguson and Fraser (1998). So these results can also be seen as encouraging.

6.5.3 Student Interviews

This college was in a more remote area of New Zealand and the researcher was unable to travel for the interviews, and therefore the regular teacher did the questioning which was probably better given the nature of the students and the rapport she had built up with them over the year. The questions asked of these students were essentially the same as for the upper and middle bands but at times for clarification the teacher expanded on them as she saw fit. The questions and responses have again been grouped under the same three general headings to enable more directed analysis. The interviews at this school were held after the end of year examinations, which were all sat as individuals.

Group functioning

The girl's group interviewed was typical of most groups during the study. They showed a consistent approach to dealing with the day-to-day running of their group.

How did you first form your group (Sue)?

We were just friends and sort of decided (Christina).

And you've been happy working together (Sue)?

Yes (Nicole).

Any reason why (Sue)?

Because we are all like good friends (Clarissa).

Well we normally sit together in most classes so (Nicole).

Is it because you are friends and you get on well together and you think that works better than if you were put into groups (Sue)?

Yes (Christina).

Yep (Nicole).

So when we look at practical work, research assignments and that sort of thing how do you divide the jobs up (Sue)?

We normally…we sort of take turns (Nicole).

So one person does one thing and the other does another (Sue)?

If you look at something and one person picks one thing and the other person and the last person is stuck with the last thing (Nicole).

What about in experiments is the same person doing the same job all the time (Sue)?

No (Christina).

No (Clarissa).

Spread it out (Nicole).

What do you do if someone in the group is slacking a bit (Sue)?

Probably leave the work for them that didn't get done (Nicole).

The boy's group, however, encountered early problems at the initial set up of their group but to their credit they worked their way through any issues in a fair and cooperative manner. The comments below support this assertion.

How did you first form your group (Sue)?

It was actually me and Ricky at the front until ... and then we split paths and said righty oh we'd go in different groups. Me and Ricky stayed together and Phil came over to our group (Andy).

Because I got kicked out of the Zane. and that's when I decided to link up with Andy because I get on quite well (Phil).

Do you think you've worked quite well together as a group (Sue)?

Yep we may have had our differences but Yep (Andy).

But you think you've worked through them adequately (Sue).

Yes (Phil).

So you're enjoying working in your groups (Sue)?

Yep (Ricky).

Yeah (Andy).

Practical work. When you're doing practical, research or assignments, how do you divide up the jobs (Sue)?

Like one does the writing, one gets the gear and maybe the other does the experiment (Andy).

So you keep changing jobs (Sue)?

Yes (Phil).

What would you do if one person in your group were slacking a bit? Has that happened (Sue)?

Yep. We told him well you'd better do that or you will be letting the whole team down (Andy).

Has one person become the boss (Sue)?

No (Ricky).

No all (Andy).

Overall the day-to-day running of the teams was well organized and when given the opportunity it can be seen from the response of the students above that they took their group work seriously.

Group dynamics and change

The students from this class showed that they had also evolved the way their group operates and followed good cooperative principles; the evidence for this is documented in their responses below.

Do you think that as a group your results have been better than if you're working by yourself (Sue)?

Yep (Clarissa).

Yes (Nicole).

Why do you think that (Sue)?

Because you've got three people's brains not just one (Nicole).

And you know different things (Christina).

And sometimes where there are situations where two people don't agree (Sue)?

Yeah (*Christina*).

What do you do then (Sue)?

Compromise (Clarissa).

So you go on a majority rule thing (Sue)?

Yep (Clarisa).

Does group or teamwork have any application to being in the workforce do you think (Sue)?

Yes (Christina).

Why (Sue)?

Heaps of people work in teams (Clarissa).

Like if you've got a group of people working, it doesn't necessarily be a team (Nicole).

The boys also responded in a similar way to these questions. They also showed a mature approach towards their group work.

How do you sort out your groups answer if you disagree (Sue)?

We contribute to it and then sort of churn it and mix it up and say well it's such and such (Phil).

Do you think doing this group work has any application to the workforce (Sue)?

Yes it would because any job you have to work as a team and if you're stressed out you can still go to your friend (Andy).

It's not an individual job it's always a team (Phil).

It's a hundred people not a hundred individuals (Ricky).

The benefits

The students showed obvious enjoyment in working together in their groups. They also showed an appreciation of how the group work had been beneficial to them. The following comments help to illustrate this.

If you were given the option of working in groups or as individuals for the next year what would you prefer?

I'd say groups (Nicole).

Go for groups (Clarissa).

Do you find science easier working in groups (Sue)?

Yes (Clarissa).

The vast majority of the respondents simply replied 'yes' to this question with the boys' responses very similar in nature again showing enjoyment in their group work.

If you were given the option of working in groups or as individuals for the next year what would you prefer (Sue)?

Definitely a group (Andy).

Do you find science easier and more enjoyable in groups (Sue)?

Probably more enjoyable, because you can say funny jokes (Andy).

Yes (Phil).

All of the students interviewed said that they would prefer to work in groups and that it was in fact more enjoyable to work in groups.

How do you think your results compare from your group work compared to what you did in the exam, I mean by that. Do you think you would have done better in the end of year exam if you'd done al the work by yourself or do you you've done better having worked in groups?

Groups like if you didn't know something and someone wrote it down you'd be able to read it and learn (Christina).

This response shows that the students appreciated some of the benefits for having worked in groups.

6.5.4 Teacher Interviews

The teacher of this class was impressed with how well the students responded to this type of work. The students passed their own class tests and were able to pass tests set for the mixed-ability classes in the next highest band. Some responses to questions illustrate the teachers' perceptions of how well this class has performed.

How do you think their work in groups affected their self-esteem (researcher)?

Self-esteem improved significantly. They were no longer leaving gaps in tests; the assessments were learning experiences for them when they could share what they knew with others. Science still wasn't necessarily their favourite subject, that would be physical education, but they were enjoying it a lot more (Sue).

You have mentioned that they were performing a lot better in the tests (researcher)?

Yes they did. In the end of year exam they outperformed themselves really. The head of junior science approached me and said how well they had done compared to similar classes in other years, and that was in an exam they had to sit as individuals (Sue).

Do you think it is worthwhile doing their work and assessment in this way (researcher)?

I do, and if I had another bottom-band class I would use that type of assessment again. In the school I am in now all the classes are of mixed ability. However, I am looking at carrying out some, not all, of their assessment in this manner as well. I am still considering this (Sue).

Long-term benefits

The teacher of this class was very enthusiastic about the students' progress while on this programme which is evident from her interview at the time. She did also make a comment that science in fact became their second most favourite subject, only being edged out by physical education. A significant number of the students over the next two years continued to show good progress in their science and some of them sat and passed School Certificate Science (this was a nation-wide examination for Year 11 students). The self-esteem, confidence in their own ability and attitude to their science can be inferred from this to have improved significantly.

6.6 OBSERVATION BY THE RESEARCHER AND VIDEO ANALYSIS

6.6.1 Introduction

Observation of the students at work in their groups was undertaken to establish how well they were operating as teams. These took place in the middle part of the year when the group dynamics were well established. The best occasions to observe the groups were during practical work, where good teamwork is paramount, and team testing where cooperation and contributions can be easily observed. The key indicators of group functionality looked for by the researcher during observations both in person and by video were:

- Enjoyment and enthusiasm exhibited while working together.

- The establishment of relevant procedures to ensure the effective operation of the group.
- Relative contribution to the group effort by its individual members.

6.6.2 Practical Work

During practical work the cooperative nature of the groups was in most cases very apparent, equipment was collected and returned efficiently by the designated person, the experiment was set up and performed well. The buzz of chatter, most of it on task, was also apparent. There was some off task talk but it was usually restricted to short comments to each other and the work being undertaken was never compromised, essentially a group of friends at work. There was also opportunity here for the researcher to informally talk to students about how they were enjoying working in their teams and most were very positive about the experience at this time. Some groups were better organised than others with the poorer groups coming from the mid band classes, but they still worked effectively and there were no seriously dysfunctional groups observed. The mid band groups, which operated best during practical work, were always from classes where basic routines had been well established by the teacher. These students seemed to get more confidence from clear guidelines and worked better together. The clear roles of each of group members such as, equipment manager, technician and recorder helped to ensure that all students had a role during the practical work and there were no 'freeloaders'.

In classes with less defined roles some groups of girls in particular sometimes had a very competent technician who liked doing the experiment while the others stood back. The teachers usually tried to ensure that there was an even workload through out the group.

6.6.3 Group Testing

The 'on task' nature of students engaged in a team test was universal in all classes observed by the researcher, both in person and by video analysis. There was invariably a lot of communication within groups occurring with the entire group being involved and contributing. Generally the girls talked through possible solutions to problems more than the boys who usually arrived very quickly at the 'correct' answer. The boys' teamwork certainly improved significantly over the course of the study. From informal discussions with the boys and their teachers they were aware that in general the girls initially were better than the boys in the teamwork aspect but the boys had clearly improved.

Teachers usually circulated around their students during these group tests. They were able to get around all of the groups helping with problem solving techniques and keeping an eye on the group functioning. In most cases there were only nine groups of three students to assist and the students seemed to enjoy this additional contact with their teacher on an almost individual basis. The students said that it was good having some teacher help on how to answer some questions.

Overall both the teachers and the students enjoyed the cooperative work of the students during group tests as both a testing and learning experience. The standard of cooperative work was very good with the reward of good marks for their team being a key focal point.

6.7 SUMMARY: THE EFFECT OF COOPERATIVE GROUP WORK AND ASSESSMENT ON THE ATTUTUDES OF STUDENTS TOWARDS SCIENCE

This chapter has outlined how students' attitudes towards science have changed over the course of the study using a range of methods both quantitative and qualitative. The attitudes of students within two broad bands, the upper, middle band along with the lower band has been investigated and results analysed. While the study has focused mainly on the time frame of one year the opportunity to look at a longitudinal case study has also been included in the results. Overall the study has used a diverse approach to generate meaningful data on student attitudes towards science. The results from this study suggest that cooperative learning and group assessment provides an effective means of improving student attitudes towards science. The results of the TOSRA throughout the study may not reflect dramatic changes over the time frame of the study, but they do support the suggestion that changes of student attitudes have occurred. The students and teacher interviews add significant weight to the assertion that positive changes have occurred to student attitudes and that they enjoyed working in their cooperative groups. The inclusion of the lower band of students has led to results which show considerable promise for this group of students who often struggle for motivation in a regular classroom structure.

While improvement in cognitive learning was not a focus of this study some indications from student and teacher interviews suggest that this may in fact be the case and as such be worthy of further investigation. Remarkably this style of cooperative learning may actually result in reduced teacher workload with considerably less marking during formative assessments in cooperative groups. Furthermore, the process is non-intrusive on the effective delivery of the curriculum and the day to day running of the classes which the participating teachers have said, are important considerations when considering use of cooperative learning in secondary schools.

The establishment of cooperative group work and assessment, which is most unusual in secondary schools, may in fact be a simple yet effective method of improving student cognitive learning outcomes and attitudes.

CHAPTER 7

CONCLUSION

7.1 INTRODUCTION

This thesis reports on how cooperative group work and assessment can be used to positively influence the science related attitudes of Year 9 and 10 students in New Zealand secondary schools. While the use of cooperative group work is not new, the simple method of group establishment and the incorporation of all assessment activities and practical work during the year provided the basis for this unique study.

The initial thrust for this study was generated through the researcher's own teaching and observation of student attitudes towards science. Students throughout most New Zealand schools are assessed as individuals on a regular basis from the first time they enter secondary school. For many, this is not always a positive experience. The students who exhibit less positive attitudes towards what should in fact be a fascinating and relevant subject reflect this. They are expected to work well in teams when they enter the work force and yet are given little significant training for this. After some preliminary work by the researcher and some work on group testing by Atkins (1993), this study to further investigate cooperative group work and its effect on student attitudes was initiated.

During the course of the study to establish the effect on student attitudes of cooperative group work and assessment, a number of significant contributions have been made to the growing pool of knowledge on this topic.

The first significant contribution is in the validation of the Test of Science Related Attitudes (TOSRA) after initial development and validation in schools in both Australia and the USA by Fraser (1981a), for the first time in New Zealand schools.

A second significant contribution is made in the comparisons of the science-related attitudes of several subgroups of the study population. The effects of gender, grade level and band on student attitudes were investigated along with consideration of the role of the teacher and general classroom environment. The TOSRA yields separate scores for a number of distinct attitudinal aims instead of a single score, this means that a profile of attitudinal scores of the various subgroups have been able to be accurately assessed for any statistically significant variations.

The triangulation approach to the effect of group work and assessment on the science-related attitudes of Year 9 and 10 students makes a third significant contribution. The quantitative data generated through the use of the TOSRA along with qualitative data obtain through student and teacher interviews all help to build an accurate picture of student attitudes.

Much of this work was carried out during the period of the study in 1998, however there have been some significant results, modifications and improvements during the ensuing period with some of this reported in Chapter 6 (longitudinal case study and the lower band students). There have been a number of new initiatives introduced in more recent times and these are reported later in the body of this chapter.

Consequently, this study is distinct in its contribution to the fields of cooperative group work and assessment along with the assessment of science-related attitudes of our students.

Perhaps the most significant contribution is the addition of a simple, effective method of improving the attitudes and enjoyment that students obtain from their science lessons. The ensuing improvement in understanding and teamwork through working with their peers is most likely to occur as a result of this work. Teachers can easily incorporate these techniques into their current teaching with no corresponding increase in stress or workload.

7.2 OVERVIEW OF THE STUDY

The context of this study is in the field of cooperative group work and attitudes towards science. Chapter 2 outlined the literature in this area and while there was significant work as early as the 1700s the modern era is generally considered to have started in the mid-1960s by Johnson and Johnson of the University of Minnesota.

There have been significant contributions to cooperative group work by several researchers and these were outlined in the chapter. There was a focus on how groups are best structured and the conditions in which they are found to operate most effectively by a number of significant researchers.

The research into attitudes was traced in Chapter 2 starting with some initial problems with getting a widely accepted definition of the term. The first attempts to make quantitative measurements of attitudes also were traced with some identified as early as 1928, but the birth of the modern era is considered to be the mid –1960s. Attention is given to the development of various instruments including the TOSRA by Fraser (1981a), which yielded a separate score for a number of attitudinal aims rather than just one overall score.

The methodology to establish cooperative groups on a simple yet effective basis and the selection of the schools, teachers, classes and students along with the subsequent measurement of students' attitudes was outlined in Chapter 3. Selections of appropriate procedures for the collection of quantitative and qualitative data from the study were discussed along with any additional information from the longitudinal studies running over a longer time frame.

With the TOSRA being the instrument selected to collect quantitative data on student attitudes, its validation and reliability was outlined through in Chapter 4. The profiles and subsequent comparisons of various subgroups students based on gender, school, grade and band were reported in Chapter 5. Significant differences and possible explanations were also discussed within this chapter.

Underlying the research is a desire to improve the attitudes of students towards science. Consequently Chapter 6 described how cooperative group work and assessment affects the science-related attitudes of the students who took part in this study. Thorough examination of quantitative data from the TOSRA and qualitative data from the interviews of students and teachers along with researcher observations yielded a reasonable picture of the attitudes of the various student groups who participated in the study.

7.3 MAJOR FINDINGS OF THE STUDY

7.3.1 Objective One

The first objective of this study was:

> *to provide validation data for the use of the Test of Science Related Attitudes (TOSRA) in New Zealand.*

The TOSRA was developed to measure the science related attitudes of students, in this case those in Years 9 and 10. It has the advantage over other science attitude tests of providing distinct attitudinal aims rather than a single overall score. This means that student attitudinal profiles can be drawn and any statistically significant changes can be inferred. Comparisons between individuals or groups of students can be made or if the test is taken on two separate occasions any attitudinal changes, even if for only one of the scales, can be monitored and assessed. Hence there was a need to validate the TOSRA for New Zealand students.

The statistical validation of the instrument was reported in Chapter 4 and several measures were used in the validation of the TOSRA. In the factor analysis where a correlation matrix of all 70 original TOSRA items was presented and then manipulated to leave a 55 item instrument with satisfactory correlations with most being at least 0.55. The internal consistency of all of the scales was shown to be well above the minimum acceptable levels through the use of the Cronbach alpha coefficient. The only exception was the Adoption of Scientific Attitudes scale, which was reduced to only four items as a result of the factor analysis. The discriminant validity of TOSRA was measured using the scale's mean correlation with other scales and this showed that the items used in the instrument correlate far more with items in the same scale than with items in other scales. Overall the instrument TOSRA was found to have satisfactory discriminant validity. These results compared favourably with those from Australia schools reported by Fraser (1981a). The overall conclusion that can be drawn from the descriptive statistics is that the TOSRA is a reliable and valid instrument for use in New Zealand schools.

7.3.2 Objective Two

The second objective of this study was:

> *to determine relationships of grade and gender of students with their attitudes to science.*

The quantitative data generated by the TOSRA were useful in the establishment of some trends and patterns within the subgroups of the population and this was fully reported within Chapter 5. When the science related attitudes of boys and girls across the entire population are compared, the girls exhibited more positive attitudes towards the Normality of Scientists scale while the boys were more positive towards the Enjoyment of Science Lessons and the Leisure Interest in Science.

When students are further split into classes and levels, the results show that the gender and experience of the teacher could in fact also have some bearing on some of the attitude scales of boys and girls. The younger teachers, both male and female, generally have a more polarizing effect on the boys and girls within their classes. There were often no corresponding statistically significant differences in science-related attitudes between the boys and girls when the teacher was older and more experienced.

Recent work by researchers such as Jones, Howe, and Rua (2000) has shown that background including aspects such as culture and the out of school experiences continues to make a significant contribution to boys' and girls' attitudes and perceptions of science. This is still likely to over ride any of the experiences students may experience during their science lessons at school until perhaps they reach the senior school when they are mature enough to form attitudes on a more informed basis.

7.3.3 Objective Three

The final objective of this study was:

> *to determine the effect of a cooperative approach to learning and assessment on the attitudes of students to science.*

There is significant and varied evidence presented in Chapter 6 to support the assertion that cooperative group work and assessment does in fact have a positive effect on the science-related attitudes of Year 9 and 10 students. Data from the TOSRA and student and teacher comments during both formal and informal interviews have supported this work as both enjoyable and effective. Observations by the researcher also support this statement.

The key to the success of any cooperative learning programme is the way the groups are established, how they operate and the types of tasks they are set. In a secondary school, group work needs to be simple and non-intrusive on the regular delivery of the curriculum or it will not be done given current teacher workloads and conditions. Johnson and Johnson (1999) suggest that student selected groups may result in more off-task behaviour but the tasks such as laboratory work and tests have to be done in a set time frame and as such there is little opportunity for off-task behaviour. The group mark is an incentive to work well and while Johnson and Johnson (1989) suggest the cautious use of incentives Slavin (1989) maintains that students must have a good reason to take each other seriously. The way that students assist each other with explanations, particularly during group tests, certainly helps them learn more. Group testing falls into line well with the collegial model proposed by Cohen (1986) where the statement 'Peer explanations are often excellent, and those who explain often show intellectual gains as a consequence' (p. 56) perhaps best sums up students working cooperatively on a difficult problem during a group test. Work by New Zealand researchers Brown and Thomson (2000) also supports peer teaching and they go on to suggest that one of the four ideals teachers and students need to build on while establishing their groups is the need to have fun. 'Enjoyment in learning is one the big pluses of cooperative learning. In cooperative classrooms it is easy to meet the students' need to have fun' (p. 59).

7.4 SIGNIFICANT IMPROVEMENTS

Much of the research presented in this thesis is based on the data collected over a one-year period involving 13 classes from the four schools participating in the study. There have been some significant developments by the researcher during the course of his regular teaching programme. A number of these are improvements, which add significantly to the study and the implementation of a more successful and rewarding cooperative learning programme. These will be discussed here, as research of this type should perhaps be best viewed as seamless in nature with no finite ending. The year of implementation of these changes at the researchers own school has been noted along with each of the recommendations.

7.4.1 Review Testing

After students have completed a test, the going over of the answers is often seen as a waste of time by students yet teachers know that reviewing where you have gone wrong in a test is very important as we learn from our mistakes. One of the strategies introduced to help this and build the teamwork is the review test. Johnson and Johnson (1994) suggest that one of the four levels of group functioning, fermenting, requires students to 'ferment' their ideas through thorough review, justification and explanation. The review test does this with the added incentive of increased marks for the group. This was first trialed during 1999 by the researcher at School 3.

Groups are returned their test scripts with their marks including those questions to which they have incorrect responses. The groups are given approximately 15 minutes to go over the test in their groups noting which ones were incorrect. They are then given the opportunity to go home and prepare for their review test, in which they are given the same test again with reduced time. They then resubmit their tests for marking and the new mark as a fraction of 100, is multiplied by half of what they missed out on the first time and added to their original mark. This is their new mark with a maximum of their original mark plus half of what they missed should they score 100 percent in the review test. Hence, a team who scored 60 percent would be able to raise their mark to a maximum of 80 percent should they get 100 percent in the review (Murray 1990). There are obviously variations to this, such as the students doing the review test in class as soon as they get their scripts back using an 'open book' policy where they have to use their notes and texts to work out the missing answers.

This strategy has been very successful with the students enjoying the opportunity to increase their group mark. The increased cooperation and opportunity to learn more as they try for more marks has proved to be worthwhile. The teacher does have to re-mark the tests but it is reduced the second time and since there are only 9 or 10 scripts in a class this is still less onerous than tests taken by individuals.

7.4.2 League Tables and Group Names

The students certainly enjoy naming their group or learning team and come up with some imaginative titles. A natural extension of this is the introduction of 'league tables' where each groups place is listed on a chart in rank order. The groups are given a mark for their placing in each event (any task that is marked) such as 10 for first and one for last. The teacher can set up tasks such as a practical activity where the identity of various chemicals has to be found and the first group with the correct mark provided to the teacher receives the top mark and so on. If there is a range of tasks, every group will have an opportunity for their moment of glory. Students enjoy this aspect of their group work and even the lower ranked students enjoy the chances they get. They are working together to achieve more but not on their own. A sample 'league table' can be found in Appendix E and again this was first trialed in 1999 by the reseacher.

Johnson and Johnson (1999) suggest that all three structures: competitive, individualistic and cooperative can be integrated within one lesson. They believe that students should be able to compete for fun and enjoyment. The use of names and league tables falls into line with these statements.

7.4.3 Senior Students: Revision Tests

As students progress through from the junior school (Years 9 and 10) to the senior school their main focus is the passing of external examinations and as the subjects become more abstract they find this more difficult. The researcher found during 1999 and 2000 that students who have been in his junior classes and experienced group testing will often ask after a chemistry or physics unit, 'Can we do this test in our teams please as we are finding this harder and want to learn off each other?' This gives them an opportunity to work through difficulties with their peers as the teacher circulates around the class. The students can do more of these formative assessments with no corresponding increase in teacher workload since fewer scripts need to be marked. Teachers do not usually use assessment and the data generated to alter their curriculum delivery (Gallagher, 1987: Salish, 1997). In a study on assessment on middle school science classes by Treagust, Jacobowitz, Gallagher and Parker (2001) the implication was drawn that it is possible to develop an assessment culture in schools, as opposed to a testing culture. This type of assessment has been described as 'ongoing embedded assessment' (Gallagher, Parker & Ngwenya, 1999; Wiggins, 1998). Treagust et. al. (2001) also make the statement that 'the integration of teaching with assessment does lead to improvement of science teaching' (p. 137).
Some aspects of group assessment can be carried out in the senior school and the students find this very helpful of their study programme. This has been trialed

7.4.4 Team Practical Examination

A team practical examination for all Year 9 students initiated by the researcher has been operating very successfully in School 3 since 1997. The students operate in their usual groups and are roistered into two adjoining laboratories where the experiments are set up. The experiments are new to the students and involve rotating around each of the workstations. They complete one paper for their group during which the tasks for each group member are carefully defined with their names being listed on the first page under each of the following headings: equipment manager, technician and recorder. These roles are rotated at each workstation to ensure all members get an opportunity in each of the roles. The experiments are balanced between each of the science disciplines with a molecular modeling exercise also included. The examination can be found in Appendix F.

The students really did enjoy working in this examination; they were able to talk among their group but not between groups as with their regular group tests. The top students were often not from the upper bands as would be the case in a written examination done as individuals but from a range of classes. The practical was very easy to administer and mark.

7.4.5 Problem-Based Learning

The researcher at School 3 has implemented problem-based learning in cooperative groups. This has been with upper band students at Year 10 and was first implemented in 2000. The students are given a problem or scenario, which they are required to solve in their groups. In order to solve this they need to study various aspects of the unit being studied. Resources are provided along with the teacher to help them achieve this. The students have found this a really enjoyable way of learning the unit and they have produced excellent notes and resources, which can then be used as a reference later in the year. Units such as the human body studied in the context of their favorite sports team have proved very successful. This has also been implemented very successfully at tertiary level in New Zealand and Australia in Physiotherapy. Students in teams of three or four are assigned to the case study of a patient who has presented with a particular disorder, which is described. The students have to suggest the possible causes, followed by suitable diagnosis sequences, and then a treatment and management plan over a suitable time frame. The students studying under this process have learned far more effectively than those in conventional classes according to Reid (2004), Acting Head, Division of Rehabilitation and Occupation Studies, Auckland University of Technology, New Zealand. Problem-based learning in groups is powerful means of giving students more ownership and enjoyment from discovering for themselves key aspects of a unit.

7.4.6 Concept Cartoons

This use of argumentation in science through concept cartoons (Naylor, Keogh, & Downing, 2001) has proved to a valuable tool for use in cooperative group work and has been a regular part of the programme at School 3 for Year 10 students since 2002. Some excellent discussions among group members have lead to a better understanding of concepts which students often find more difficult.

7.5 IMPLICATIONS OF THE STUDY

One of the immediate implications of this study is that an instrument, which has been demonstrated to clearly differentiate between various groups of students, has now been validated for New Zealand conditions. Whether it is for comparing various subpopulations or monitoring changes in attitudes it is a powerful instrument in that it can look at the various aspects of attitudes rather than just an overall attitude score. Hence, it is useful instrument for New Zealand researchers in science education.

Implications for the teachers of science are that there is now a simple, easy to manage cooperative group structure, which can readily be established in a regular science classroom. There is no need to make any changes to the way that the curriculum is delivered and teacher workload may in fact decrease.

Some teachers have expressed a concern that each test the students take does not generate an individual mark for each student but a group mark. Teachers involved in the study found that this became much less of a concern as they saw the academic progress and enjoyment that the students obtained from their cooperative group work.

Essentially, students are assessed as individuals at the end of each year and it is our job as teachers to choose the path that allows the students to achieve the best possible result in the final end-of-year assessment. The choice of a path where students have worked together as a valued member of a cooperative learning team during the course of the year and also emerged with more positive attitudes towards science would appear to be more sensible. Treagust, Jacobowitz, Gallagher and Parker (2001) see the development in the middle school of an assessment culture as opposed to a testing culture as desirable for student cognitive outcomes. Baker (1998) notes that the test-taking situation does interact to some extent with the format of the assessment task.

New Zealand has moved away from a norm-referenced assessment system to a standards-based assessment system. The NCEA (National Certificate in Educational Achievement) was implemented for the first time for Year 11 students in 2002 followed by Year 12 in 2003 and finally Year 13 in 2004. This system is a combination of internal work during the course of the year and also external examinations at the end of the year. Group testing of students in the lead up to both internal and external assessments for NCEA is ideal preparation as students and their teachers work together during the tests in a formative manner. If the students have been involved in a cooperative learning culture of this nature in the junior school they should be better prepared for their science from Year 11 onwards with better cognitive and attitudinal outcomes.

Some schools in New Zealand are now implementing a more rigorous testing programme in order to better prepare students for the NCEA style of testing they will experience. This may in fact have the reverse effect for our lower ability students if they are to perceive even more failure in the junior school. Meece and Jones (1996) make the statement that ‘the task for teachers is to create classroom environments where low-ability students can put forth effort without fear of failing or appearing dumb’ (p. 403). This statement supports the concept of cooperative group work and assessment for lower ability students. This study proved to be an outstanding success with the group of students of this nature.

Finally, we do little training of students for working in teams yet several managers and CEOs have explained to the researcher that the ability to work as part of a team is the most important aspect to consider of a potential employee. Ellis (2003), General Manager of the highly successful Republik advertising and marketing company based in Auckland, New Zealand, explained how important it was that various strands of advertising are linked together by the people responsible from several different departments to produce a final advertising and marketing strategy. They must work together as a team to achieve this effectively or they will not compete.

He was asked the following question. When hiring new staff what are you looking for as important qualities and if possible rank these?
Most important is that they fit the culture of our company and after that their qualifications and experience.

Hence some training of our students in cooperative group work is a useful tool to them for their future employment opportunities.

7.6 LIMITATIONS OF THE STUDY

An obvious limitation of this study is that any of the conclusions drawn from the data relate only to this sample of students. The schools selected were all of a similar nature in order to manage the variables to allow meaningful comparisons of students within this population. City schools did not form part of the study and as such the impact of such a group cannot really be ignored when considering any inferences made from the results.

A second limitation lies in the size of the samples as the numbers are broken down into smaller subgroups of the original population. Statistically, some of the results and implications may need to be treated with caution. The other size limitation imposed is that when the effects of the longitudinal study conducted by the researcher are considered and conclusions drawn. This group was initially set up as a pilot trial prior to the main study, but since the students involved were still at School 3 and keen to be involved it was seen as an opportunity to evaluate cooperative group work and assessment over a longer time frame. The results from this have been treated cautiously. The same applies to the group of 18 students in the lower band of students at college 4. There were very few of these groups in existence in New

Zealand schools at the time of the main study with most of these students being 'mainstreamed'. There has, however, been a swing towards more of them again with these students struggling to achieve in mainstream classes and still suffering from poor self-esteem as a consequence.

7.7 SUGGESTIONS FOR FURTHER RESEARCH

7.7.1 Cognitive Outcomes of Cooperative Group Work and Assessment

This study has focused on the change in Year 9 and 10 students' attitudes when working in cooperative groups for their class work and assessment activities. There have been some inferred improvements from statements by students and teachers; however, investigations on the effect of cooperative group work and assessment on the cognitive outcomes of this group of students would be an exciting possibility. In New Zealand during 2002 and 2003, there has been a national testing programme established to monitor the relative achievement of Year 9 and 10 students. This is known by the acronym MIDYIS (Middle Years Information Systems) developed by Durham University in the UK and is administered by Canterbury University, New Zealand. This is standardised and around a third of New Zealand schools are using it but this is expected to increase rapidly. This would provide an excellent and consistent means of comparing groups of students involved in such a study.

7.7.2 Student-Teacher Interaction

The possible effect of the teacher on students' attitudes was alluded to in Chapter 5 where several observations as a result of the TOSRA results of various subgroups of students were made. In a study by Rickards (1998), the statement 'for a more positive student attitude to class, the behaviours of leadership, helping/friendly, understanding and student responsibility and freedom were positively associated to attitude to class' (p. 152.) outlines one of his implications. This would provide the basis for an interesting follow-up study looking at cooperative group work and assessment alongside student/teacher data generated through the use of some of the classroom environment instruments such at the Questionnaire on Teacher Interaction (QTI) (Wubbels, Creton, & Hooymayers, 1985).

7.7.3 City Schools

As mentioned previously in the limitations of this study, the students within our city schools have not been part of this study and as such would be an interesting extension to the data collected on basically rural students. While the two groups are perhaps not as distinct as they were before the advent of communications such as text messages cell phones, instant computer messaging, a comparison of the two groups would make for interesting research.

7.7.4 Māori Students and other Cultural Groups

As with most state secondary schools the lower achievement of our Māori students is of concern. A number of schools including School 3 have a Māori initiative where Year 9 Māori students are taught as a group enabling much of the teaching to be in a Māori context. This provides the opportunity to teach using cooperative group work and assessment to a class of Māori students. The Māori culture has a lot of tradition in cooperative work as part of day-to-day life, as do a number of other cultures within New Zealand. A study of any such minority groups whose culture is perhaps predisposed towards cooperative group work would be an interesting and useful contribution to New Zealand society which has become truly multicultural.

7.8 FINAL COMMENTS

This study has identified an association between cooperative group work and assessment for Year 9 and 10 students and their science related attitudes. This is the first study of this nature and with such encouraging results and such a simple format for the effective establishment of student groups it is hoped that teachers will consider this approach for their science teaching. The opportunity to allow students to develop their interpersonal skills in a team environment, along with their understanding and enjoyment of science, is well worth the effort required to establish cooperative group work. As teachers we cannot sit back and allow significant numbers of our students to have negative attitudes towards the exciting and vital subject of science without trying to improve this.

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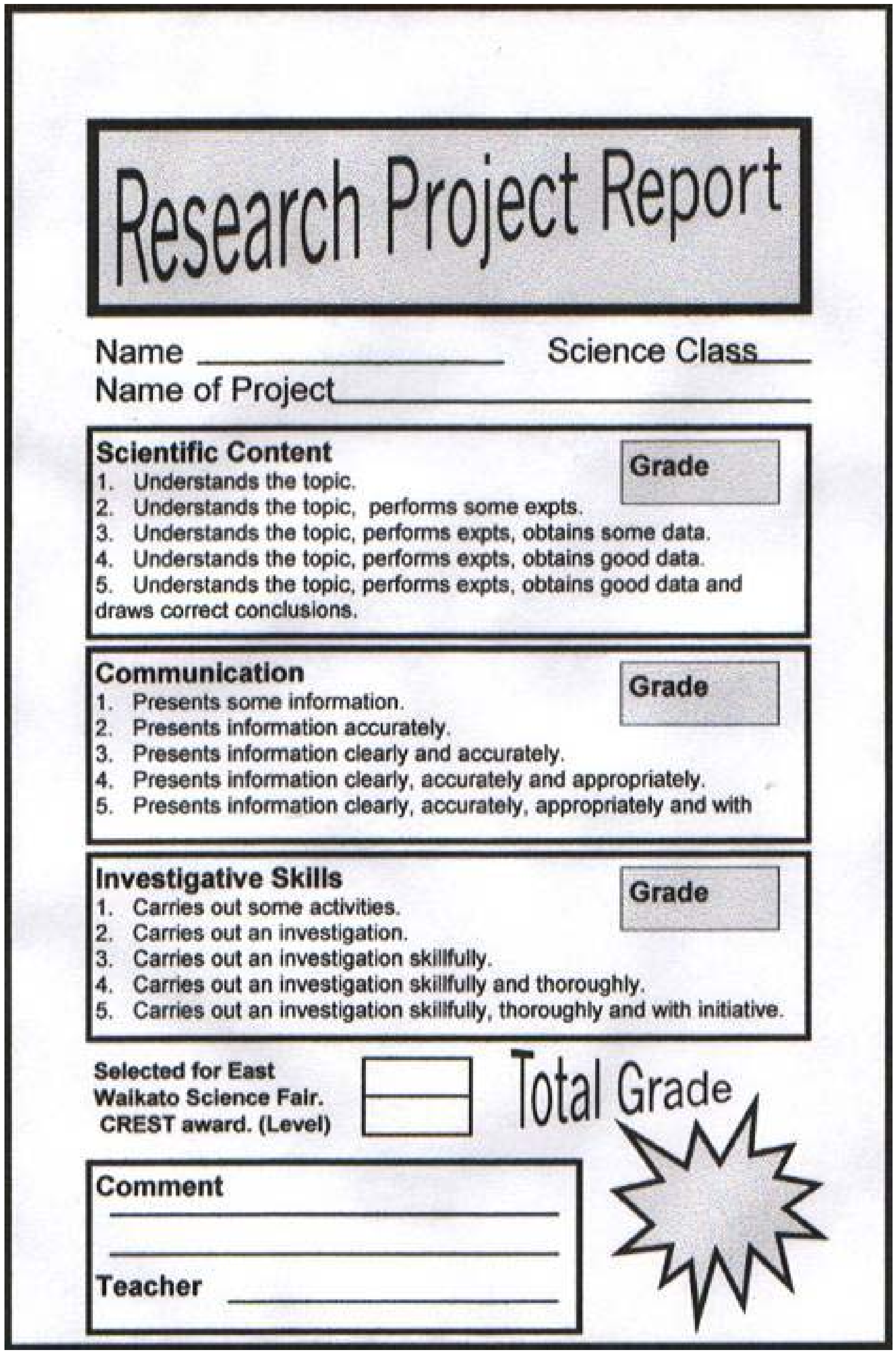
APPENDICES

Appendix A Research Project Report



Research Project Report

Name ____________________ Science Class ____
Name of Project ______________________________

Scientific Content **Grade**
1. Understands the topic.
2. Understands the topic, performs some expts.
3. Understands the topic, performs expts, obtains some data.
4. Understands the topic, performs expts, obtains good data.
5. Understands the topic, performs expts, obtains good data and draws correct conclusions.

Communication **Grade**
1. Presents some information.
2. Presents information accurately.
3. Presents information clearly and accurately.
4. Presents information clearly, accurately and appropriately.
5. Presents information clearly, accurately, appropriately and with

Investigative Skills **Grade**
1. Carries out some activities.
2. Carries out an investigation.
3. Carries out an investigation skillfully.
4. Carries out an investigation skillfully and thoroughly.
5. Carries out an investigation skillfully, thoroughly and with initiative.

Selected for East Waikato Science Fair.
CREST award. (Level)

Total Grade

Comment ____________________
____
Teacher ____________________

Appendix B School Codes: Class, Year, and Band
(1998 pre and post group work)

SCHOOL	CLASS	YEAR	BAND	TEACHER	CODE: PRE	CODE: POST
School 1	C1	Y9	M Middle	Teacher A	S1C1Y9MPre	S1C1Y9MPost
School 1	C2	Y9	U Upper	Teacher A	S1C2Y9UPre	S1C2Y9UPost
School 1	C3	Y10	M Middle	Teacher B	S1C3Y10Pre	S1C3Y10Post
School 1	C4	Y10	U Upper	Teacher B	S1C4Y10Pre	S1C4Y10Post
School 2	C1	Y9	M Middle	Teacher C	S2C1Y9MPre	S2C1Y9MPost
School 2	C2	Y9	U Upper	Teacher D	S2C2Y9UPre	S2C2Y9UPost
School 2	C3	Y10	M Middle	Teacher D	S2C3Y10Pre	S2C3Y10Post
School 2	C4	Y10	U Upper	Teacher C	S2C4Y10Pre	S2C4Y10Post
School 3	C1	Y9	M Middle	Teacher E	S3C1Y9MPre	S3C1Y9MPost
School 3	C2	Y9	U Upper	Teacher F	S3C2Y9UPre	S3C2Y9UPost
School 3	C3	Y10	M Middle	Teacher G	S3C3Y10Pre	S3C3Y10Post
School 3	C4	Y10	U Upper	Teacher H	S3C4Y10Pre	S3C4Y10Post
School 4	C1	Y9	L Lower	Teacher I	S4C1Y9LPre	S4C1Y9LPost

Appendix C TOSRA Questions and Marking Schedule

TOSRA Test of Science Related Attitudes (Fraser 1981a)

DIRECTIONS

1. This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.
2. All answers should be given on the separate Answer Sheet. Please do not write on this booklet.
3 For each statement, draw a circle around

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

The TOSRA questions
1. Money spent on science is well worth spending.
2. Scientists usually like to go to their laboratories when they have a day off.
3. 1 would prefer to find out why something happens by doing an experiment than by being told.
4. 1 enjoy reading about things which disagree with my previous ideas.
5. Science lessons are fun.
6. 1 would like to belong to a science club.
7. 1 would dislike being a scientist after I leave school.
8. Science is man's worst enemy.
9. Scientists are about as fit and healthy as other people.
10. Doing experiments is not as good as finding out information from teachers.
11. I dislike repeating experiments to check that 1 get the same results.
12. 1 dislike science lessons.
13. 1 get bored when watching science programme on TV at home.
14. When 1 leave school, 1 would like to work with people who make discoveries in science.
15. Public money spent on science in the last few years has been used wisely.
16. Scientists do not have enough time to spend with their families.
17. I would prefer to do experiments than to read about them.
18. I am curious about the world in which we live.
19. School should have more science lessons each week.
20. 1 would like to be given a science book or a piece of scientific equipment as a present.
21. I would dislike a job in a science laboratory after 1 leave school.
22. Scientific discoveries are doing more harm than good.
23. Scientists like sport as much as other people do.
24. 1 would rather agree with other people than do an experiment to find out for myself.
25. Finding out about new things is unimportant.

TOSRA (Questions continued)

26. Science lessons bore me.
27. 1 dislike reading books about science during my holidays.
28. Working in a science laboratory would be an interesting way to earn a living.
29. The government should spend more money on scientific research.
30. Scientists are less friendly than other people.
31. 1 would prefer to do my own experiments than to find out information from a teacher.
32. 1 like to listen to people whose opinions are different from mine.
33. Science is one of the most interesting school subjects.
34. 1 would like to do science experiments at home.
35. A career in science would be dull and boring.
36. Too many laboratories are being built at the expense of the rest of education.
37. Scientists can have a normal family life.
38. 1 would rather find out about things by asking an expert than by doing an experiment.
39. 1 find it boring to hear about new ideas.
40. Science lessons are a waste of time.
41. Talking to friends about science after school would be boring.
42. 1 would like to teach science when 1 leave school.
43. Science helps to make life better.
44. Scientists do not care about their working conditions.
45. 1 would rather solve a problem by doing an experiment than be told the answer.
46. In science experiments, I like to use new methods which I have not used before.
47. 1 really enjoy going to science lessons.
48. 1 would enjoy having a job in a science laboratory during my school holidays.
49. A job as a scientist would be boring.
50. This country is spending too much money on science.
51. Scientists are just as interested in art and music as other people are.
52. It is better to ask the teacher the answer than to find it out by doing experiments.
53. 1 am unwilling to change my ideas when evidence shows that the ideas are poor.
54. The material covered in science lessons is uninteresting.
55. Listening to talk about science on the radio would be boring.
56. A job as a scientist would be interesting.
57. Science can help to make the world a better place in the future.
58. Few scientists are happily married.
59. 1 would prefer to do an experiment on a topic than to read about it in science magazines.
60. In science experiments, 1 report unexpected results as well as expected ones.
61. I look forward to science lessons.
62. 1 would enjoy visiting a science museum at the weekend.
63. I would dislike becoming a scientist because it needs too much education.
64. Money used on scientific projects is wasted.
65. If you met a scientist, he would probably look like anyone else you might meet.
66. It is better to be told scientific facts than to find them out from experiments
67. I dislike listening to other people's opinions.
68. 1 would enjoy school more if there were no science lessons.
69. 1 dislike reading newspaper articles about science.
70. 1 would like to be a scientist when 1 leave school.

SCALE ALLOCATION AND SCORING FOR EACH ITEM

S Social Implications of Science	N Normality of Scientists	I Attitude to Scientific Enquiry	A Adoption of Scientific Attitudes	E Enjoyment of Science Lessons	L Leisure Interest in Science	C Career Interest in Science
1 (+)	2	3 (+)	4 (+)	5 (+)	6 (+)	7
8	9 (+)	10	11	12	13	14 (+)
15 (+)	16	17 (+)	18 (+)	19 (+)	20 (+)	21
22	23 (+)	24	25	26	27	28 (+)
29 (+)	30	31 (+)	32 (+)	33 (+)	34 (+)	35
36	37 (+)	38	39	40	41	42 (+)
43 (+)	44	45 (+)	46 (+)	47 (+)	48 (+)	49
50	51 (+)	52	53	54	55	56 (+)
57 (+)	58	59 (+)	60 (+)	61 (+)	62 (+)	63
64	65 (+)	66	67	68	69	70 (+)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (-) responses SA, A, N, D, SD, are scored 1, 2, 3, 4, 5, respectively. Omitted or invalid responses are scored 3.

Appendix D An Example of a League Table

10SCM SUPA TEN

Number	Learning Team Name	EVENT and POINTS (10 for 1st Place, 1 for 10th)						
		Test1 Chem.	Prac 1 Sherlock	Test 2 Phys.	Issue Invest.	Test 3 Bio.	Total	Place
1	BLUES	10	2	8	5	6	31	4th
6	RUG RATZ	9	7	9	7	7	39	1st =
7	THE SPICE BOYS	8	9	10	4	8	39	1st =
8	CHIEFS	7	1	5	3	10	26	5th
9	HSV.HOLDEN	6	4	7	10	9	36	3rd
10	HURRICANES	5	3	6	9	2	25	6th
2	WONDER WEASILS	4	10	4	1	1	20	8th
3	SPACE GOOFS	3	5	1	8	5	22	7th=
4	RAGS	2	8	3	2	4	19	9th
5	SLIPPERY EELS	1	6	2	6	3	18	10th =

Appendix E Year 9 Team Practical Exam

Science Class:		Teacher:
Learning Team Name:		
Your names & number	**1**	
	2	
	3	

Time Allowed: 1 Hour

- You will be stationed at the same workstation for the entire practical.
- You must change your roles so that each member of your team gets a turn at each of the roles. The roles you are to do are in the table for each experiment.
- You will get marks for results and team work (ie cooperation)

Roles

- **Equipment manager**; Organises the equipment and ensure that it is all in order.
- **Technician;** Actually does the experiment
- **Recorder;** Records all the data, and results.

<u>**Experiment one:**</u>

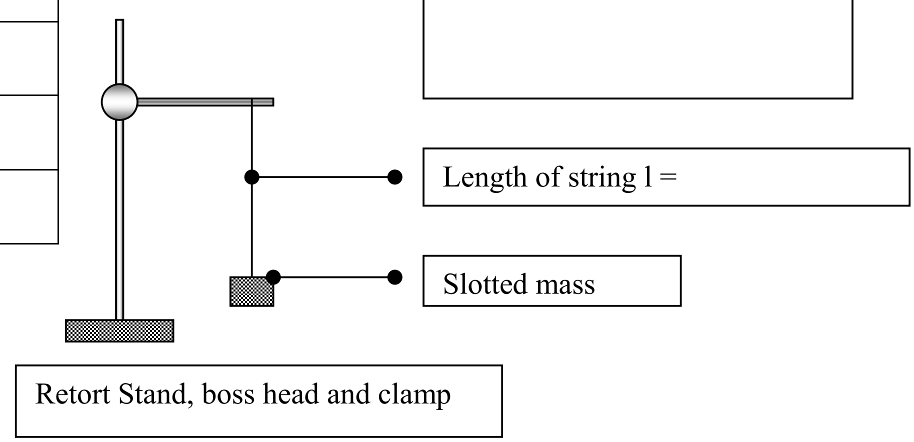
The Pendulum

The pendulum has a period of motion, which is measured from the **starting point out and back.**

Brief: You are to make a pendulum with a period of one second and measure the length of the string in mm. using the equipment supplied.

JOBS	
Equipment manager	**1**
Technician	**2**
Recorder	**3**

Expt 1 Total Mark



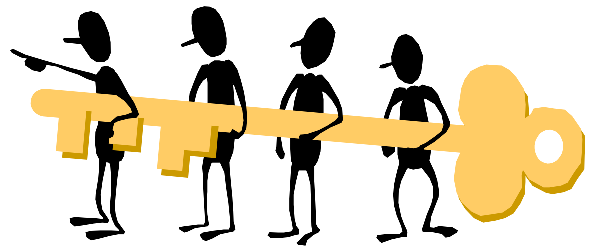
Experiment Two:

Making a Microscope slide

You are to make a slide of some onion cell, stain them with iodine and focus the microscope on them.

Equipment supplied: Scalpel, onion, microscope slides and cover slips (2X each), seeker, Iodine stain.

JOBS	
Equipment manager	**3**
Technician	**1**
Recorder	**2**



Teamwork!

Method: Try to ensure the following ideals are followed.

- The cover slip is central on the slide.
- The onion cells are only one cell thick.
- The onion sample covers no more than 1/3rd of the width and length of the cover slip.
- There are no air pockets or folds in the onion.
- There are no fingerprints on the slide.
- Make sure you put your team name onto the slide with the sticker provided.
- When you have focussed your slide using the microscope on low power, get a teacher to look at it and sign it off.

Microscope OK
Signed:

Expt 2 Total Mark:

Experiment Three:

Observing
Brief: You are to do the simple experiment and record any observations in the box provided. Make sure that you clean up after.

JOBS	
Equipment manager	**2**
Technician Wear glasses!	**3**
Recorder	**1**

1. Place 5mL of Copper sulfate into the boiling tube supplied.
2. Slowly add ammonium hydroxide to the copper sulfate recording changes as you go.
3. When there are no more changes slowly add the dil. hydrochloric acid to the mixture until there are no more changes.
4. Record the results and clean up.
5. Make sure the technician wears the safety glasses.

Action	**Observations**	**Marks**
Slowly add ammonium hydroxide	• •	
Add dilute hydrochloric acid	• •	
Clean up job.	•	
Safety glasses. (Technician)	•	

Expt 3 Total Mark:

<u>Experiment four:</u>
Making molecules

You are to use the molymod supplied to make the following molecules. Make sure that you follow the rules.

Rules:

- Make sure you use the correct colour for each molecule.
- There are to be no unfilled holes.
- There are to be no 'bonds' left unattached.
- Leave them in the tray supplied with your groups name and sticker on it.
- If there is more than one carbon join these first.

Atom	**Colour**
Carbon	Black
Hydrogen	White
Oxygen	White
Nitrogen	Blue

Name of molecule	**Formula**	**Mark**
water	H_2O	
Oxygen	O_2	
Methane	CH_4	
Nitrogen	N_2	
Ethanol	CH_3CH_2OH	
Ammonia gas	NH_3	
Carbon Dioxide	CO_2	

Well done team!

Expt 4 Total Mark:

Practical Exam
Total Mark: