Science and Mathematics Education Centre

Exploration of Collaborative Learning Environments in New Zealand Secondary School Science Classrooms

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Declaration

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

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

Signature: S. P. Taylor

Date: 8/8/12

ABSTRACT

This thesis is based on a project named *Please Let Us Take Off* (PLUTO) which recognized the need to further consider students' attitudes and perceptions of their science experiences at secondary school and to examine their immediate learning environment. Nuthall (2005) spent many years in New Zealand classrooms monitoring and analysing student interactions using microphones that recorded student conversations. His major conclusion related to how little teachers knew about what was going on in classrooms. Nuthall claimed the world of learning from a student's perspective and the specific evidence of what is happening in the student personal learning space can be unknown to the teacher. Most importantly, the project wanted to encourage teachers to take the opportunity to look closer into the student's personal viewpoint of learning in science lessons.

In the year 2008, New Zealand was introducing a new national curriculum and there was also considerable concern for non-engaged students and for Māori students in their early years of secondary school. There was appreciation of the new curriculum and its principles by schools but still an overwhelming necessity to gain further and deeper understanding of the actual learners' science experiences. Hence the attention of this study, to gain further knowledge of how students view their science learning, initially by the use of the Constructivist Learning Environment Survey (CLES). A range of qualitative student voice, including learning drawings made by students, were collected and analyzed to gain additional insight into the experiences of secondary science students.

This thesis focuses on students entering secondary school and their learning experiences in science in their first two years at years 9 and 10. It was action-research based and it followed 15 classes of students at years 9-10 (13-15 years old) with their corresponding teachers in 12 secondary schools, over three consecutive years, 2009-2011.

The selected geographical region of research incorporated a range of rural and urban secondary schools in the central North island of New Zealand. The study measured students' attitudes and perceptions of their experiences of the classroom and it

intended to generate an opportunity for teachers to discuss and reflect on the research data gathered.

The students were surveyed using the Constructivist Learning Environment Survey over two years. The data were analysed using SPSS and comparisons were made between actual and preferred learning environment results. Variations between each year, gender differences and ethnicity differences were also measured and evaluated. Student learning drawings were adopted in the year 2011 to gather qualitative voice and the drawings were analysed by considering the choices that the students made in their drawing. The student audio interviews also added a wealth of student voice to further explore the students' perceptions of their learning in science lessons. The five scales used in the CLES survey were used in the analysis of the student learning drawings and the nature of the interview questions posed to the students.

The PLUTO project endeavoured to support teacher professional learning and act as a catalyst to encourage ongoing professional discourse. It offered the opportunity to make measurements of the learning environment and at the same time help provide reasons to use different teaching methods in the science classes that may have not been used before.

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INTRODUCTION

1.1 INTRODUCTION

This chapter presents an introduction to the research. The second section describes the general background and context on how this research is situated. There is comment about some recent findings from a national educational monitoring project and the newly implemented national curriculum into secondary schools. Section three describes the overall aims and research questions. Section four explains the overview of this thesis and describes each chapter in turn. Section five describes the significance of this research. The sixth section briefly describes a summary of methods used on how the research was implemented over the three years. The seventh section describes the ethical considerations and how the students and schools were invited to participate in the study. The eighth section describes the method of data storage.

1.2 BACKGROUND

The Ministry of Education undertook a review of the New Zealand curriculum in the years 2000 to 2002. This was an important opportunity for educators to rethink many of its aims in light of the changing knowledge, skills and dispositions people need to participate successfully in 21st century social and economic life. In late 2006 a new draft national curriculum document (Ministry of Education, 2006) was released and sent out for consultation. On 6 November 2007 the final version of *The New Zealand Curriculum for English-Medium Teaching and Learning in Years 1-13* was officially launched (Ministry of Education, 2007). Since this time there has been discussion and debate over the nature of education in New Zealand schools and how it should look in the 21st century. The previous 1993 curriculum had marked a new direction, away from a focus on content and activities to one on outcomes. The 2007 NZ curriculum goes further and focuses on learners at the centre of the learning

process. It encourages teachers to actively involve students in what they learn, learn about learning, and how the learning is assessed. This model of learning encompasses generic skills and competencies like thinking, working together collaboratively in teams and being future orientated. The Nature of Science concept is a significant overarching and unifying strand to the science part of the 2007 curriculum. Students are expected to learn what science is and how scientists work. The NZ Curriculum (Ministry of Education 2007, p. 28) document states "Students are to develop the skills, attitudes, and values to build a foundation for understanding the world". It points out that students are expected to learn about how scientists carry out investigations and to come to understand science as a socially valuable knowledge system (Ministry of Education, 2007).

It is this nature of student learning and teaching that this research is interested in exploring, with particular reference to what currently goes on in science lessons at the secondary junior level and how might the current NZ curriculum be influencing the way science is being taught in science lessons. In Year 9, which is the first year for students entering secondary education in New Zealand, students are taught in specialised science laboratories and they have specialist science teachers teaching them. Students may experience science practices differently from their science experiences at intermediate and primary schooling. How different are these practices? And do the students' attitudes and perceptions of science change at secondary school due to these differing practices?

In New Zealand, we have seen recent national evidence (Ministry of Education, 2008) suggesting significant shifts in students' attitudes to science between Years 4 and 8. Just under 3000 students from 248 schools participated in the study which solely focussed on science achievement and student attitudes. The most notable change was the percentage of Year 8 students disliking science at school increased substantially from 15% in 1999 to 37% in 2007. These results of the New Zealand National Education Monitoring Project (NEMP) assessment (Crooks & Flockton, 1996, 2000, 2004; Crooks, Smith, & Flockton, 2008) has raised concerns with regard to student responses to the survey of their attitudes towards science and their reported experiences in science. The questions in the attitudinal survey had not changed between the 1999 and 2007 versions. Further to this, the percentages of Year 4 and

Year 8 students saying that they learned "little" about science at school approximately doubled between 1999 to 2007 (from 8 to 16% for Year 4 students and 6% to 11% for Year 8 students). The percentages saying that their class "never" did really good things in science increased strongly between 1999 and 2007 (from 5% to 15% for Year 4 students and 8% to 16% for Year 8 students). These survey results might be interpreted as meaning that students increasingly dislike science and therefore do not want to study science. However, between 1999 and 2007, the percentages of students wanting to do more science at school increased. This increased from 58% to 71% for year 4 students and 39% to 44% for year 8 students between 1999 and 2007. Thus, we see an interesting picture about attitudes to primary school science: increasing percentages of students dislike what is happening, but increasing percentages of students want more science.

The shifting results arising from New Zealand student responses to the survey of their attitudes towards science and their reported experiences drawn from the NEMP 2007 report, highlight the need to continue to examine the way children view their science learning. Further investigation particularly when students go through to secondary school and in the early years of secondary school is warranted. In this research, there was a possibility that a range of classroom techniques could be explored and discussed with a group of teachers to improve the immediate learning environment at the early years of secondary science. The study could involve the facilitation of practical tools such as the use of the *Constructivist Learning Environment Survey* instrument (Taylor, Fraser, & Fisher, 1997) and corresponding student voice data to support teachers in an informed, systematic inquiry into their practice. As Fisher and Waldrip (2000) remind us, if we can identify and measure socio-cultural factors of the learning environment, we have an opportunity to understand more clearly the associations between students' socially sensitive learning environment and their attitudes to learning.

1.3 RESEARCH OBJECTIVES AND QUESTIONS

The overall aim of this research is to explore the collaborative learning environments of a selection of secondary science classes over three years and collect baseline data. It also envisaged that it will be possible to interpret the findings and select student

voice to inform the participating teachers in an effective professional learning initiative.

To meet this aim, a set of four objectives was developed which became the focus of the study. This also led to two research questions to be answered.
The objectives of the research were:

- To provide validation data for the use of the Constructivist Learning Environment Survey (CLES) in New Zealand secondary schools and use qualitative student voice to further inform the project;
- To determine the effect of a collaborative approach to learning on the attitudes and perceptions of students actively with teachers in this project;
- To determine what could be done differently to improve the learning environments in secondary science classrooms in New Zealand and explore models of collaborative learning, on how changes could be made;
- To examine the implementation and delivery of the New Zealand curriculum (NZC), with particular reference to the key competencies and the Nature of Science (NOS) strand and how this could affect changes to the learning environment.

The research questions were:

- What are students' attitudes and perceptions of their experiences in year 9 and 10 science?
- How could the learning environment be changed to improve students' attitudes and perceptions?

1.4 OVERVIEW OF THESIS

There are six chapters following this introductory chapter.

Chapter 2 describes a review of the literature associated with this research. It examines six areas of interest noting historical changes to curriculum in New Zealand secondary schools and current learning environment research, with particular reference to the instrument used in this research, the Constructivist Learning Environment Survey (CLES).

Chapter 3 gives a detailed methodology and explains how the CLES and the qualitative voice were collected. The rationale for the research questions and the three objectives are also explained in detail. There are also descriptions of the school selection and demographics. There are further explanations on how the CLES was administered and descriptions of how this research has provided validation data for its use in New Zealand.

Chapter 4 presents the quantitative results in the form of summarised tables, figures and a general analysis of the results. It provides statistical information in terms of validity and reliability of the CLES, differences in the Actual and Preferred perceptions, Actual and Post Actual perceptions, gender and ethnic differences of the students.

Chapter 5 presents the qualitative results obtained from student interviews, teacher interviews, and the student learning drawings. Some narratives from the interviews have been selected to help evaluate the student perceptions and provide some overall patterns. Ten student learning drawings have been selected to give examples of how the students perceived their science lessons. The CLES scales have also been explained further because of their close association with the nature of the student interview questions and how the learning drawings were interpreted.

Chapter 6 presents an interpretation of the quantitative and qualitative findings and provides an overall discussion. There are some short discussions on the associations of the student voice with the CLES statistical significance.

Chapter 7 presents a conclusion to the study, draws the findings together with the research questions and aims. The implications and limitations of the work are reviewed and there is a final discussion about the research.

1.5 SIGNIFICANCE

The study is significant for four reasons. First, it is likely to lead to a greater understanding of how we can measure and examine teaching and learning in science classrooms. The use of quantitative instruments and qualitative student voice may provide a clearer picture of the learning environments in science classrooms in both rural and urban schools in New Zealand.

Second, the research data could likely provide new information about students' attitudes and perceptions about their science learning experiences when they enter their first year of secondary school. The study investigated the perceptions and attitudes of European, Māori and Pasifika students. Many of the schools chosen in the project had high proportions of Māori students in the classes. There have been recent tools developed such as "Me and My Schools" to measure general levels of engagement in New Zealand schools by NZCER (New Zealand Council of Educational Research) and to date, the data reported show a decline in engagement in science that begins at year 8, accelerates in Year 9 and continues into year 10. However, the studies have not had the emphasis on examining the pedagogical practice within the learning environments. This study concentrated on the student perceptions of the science learning climate around them. For example, questions such as: How much control do the students share with the teacher with regard to what they would like to learn about? How much control would the students prefer to have? How much opportunity is there for students to express their views in lessons? What relevance is there in learning science at school and their home life? How much collaboration and cooperation do students prefer in their science classes? The focus was to go deeper into the reasons for the decline in student engagement, to examine the details of the teaching practices currently, and to share this knowledge with teachers directly involved in the study and the wider science education community.

Third, the research provides evidence of what was actually happening in science classrooms and offered an opportunity for the participating teachers to see learning through the eyes of their students. Nuthall, 2005 argued that teachers can be largely unaware of the information about what individual students are learning. He found that teachers can be dependent on secondary indicators such as the visible signs that students are "on task" or motivated in completing a task. John Hattie also claims "There is a lack of student evaluations in secondary schools. The stakes are too high to depend on beliefs that quality is high, or that students are too immature to have meaningful judgements about the effects of teachers on their learning" (Hattie, 2009, p.116). The significance of this research was not to confirm a list of recommendations on effective classroom practice nor to invent pet strategies that could engage students. The aim was to support effective professional teacher discourse using evidence of the actual and preferred learning environments of their current students. Three tools of measurement of the learning environment were used which included the CLES questionnaire, student interviews and finally the use of the learning drawings to closely examine the world of the learner in science lessons. The two qualitative tools were closely linked to the CLES in terms of design to triangulate results and offer further interpretations. In the early stages of the project, each teacher participating in the study was given the quantitative CLES results of his or her class with a break-down in each of the scales.

Finally, this thesis builds on the existing and established literature and research on learning environments from Curtin University. Learning environments have received much attention from educators and researchers since Lewin (1936) proposed his B= f (P.E) formula where B= Behaviour, P= person (or people) and E = psycho-social environment. There has been extensive development with quantitative questionnaires measuring student voice over the years, with comparisons of actual and preferred environments in science learning (Fisher & Fraser, 1983, Fraser, 1998). This research continued to build on this accumulating body of reliable knowledge.

1.6 SUMMARY OF METHODS

The research involved working with 15 state secondary schools and the corresponding science teachers. Approximately 400 students were involved in the inquiry over three years. The classes investigated were at Year 9 (13 year olds) and Year 10 (14 Year olds). The schools have a range of decile ratings (1- poor socio-economic to 10 -high socio-economic) and were sited over the bulk of the central North Island.

This geographical area has both urban and rural townships and there is a predominately Māori population in the Bay of Plenty and Waikato regions within this area. Schools had approximately 5-40% Māori students attending and each school in this study had differing amounts of Māori students, this very much depended on the location of the school. In the Bay of Plenty and Waikato regions many Māori people do live in the rural and semi-rural towns. It was difficult to single out schools for example with just small numbers of Māori students and solely consider those particular schools in the research. It was better to accept the interest of all the schools and teachers who were keen to be involved in the study and get on. Some of the schools have single sex, and all classes chosen had a mixed ability range of students. Each class had approximately 25-30 students.

The administration of the CLES actual and preferred forms was scheduled for term 1 of 2009, the post actual CLES was scheduled at the end of the year. This was repeated in 2010 at the same times. Student qualitative audio voice in the form of student group interviews and student learning drawings were scheduled in term 4 of 2009, term 4 2010 and in term 3 of 2011.

Profiles were constructed from the class mean scores and cohort mean scores to inform the next steps of the professional learning for the teachers. The profiles were considered for the reflection and discussion by the researcher and the teachers.

1.7 ETHICAL CONSIDERATIONS

Students and teachers were invited to participate in the study and questions were only asked of those who accepted this invitation. An information sheet describing the project was supplied at the same time as the consent form. Written permission and consent was obtained from the parents of the students, the student themselves, the teachers and the schools involved in the study.

The parents of students involved in this study had the opportunity to withdraw their children from the study at any time if they so wished. Students also had the opportunity to withdraw from the study at any time. This would mean that they would still continue with course work but would not need to complete a CLES questionnaire or similar instrument or take part in an interview. Confidentiality was maintained during the course of this study and numbers not names were recorded. Anonymity and confidentiality were accorded to all participants and they were encouraged, but not forced to contribute to this study.

Parents/guardians were given the opportunity to be present at interviews. The interviews were audio taped and the interviews were administered with groups of two to three students. The student interviews took place in the weeks from 16-27th November 2009, 8 -26th November 2010 and 3-8 December 2011. Students' confidentiality was maintained throughout the course of the interviews, and numbers and pseudonyms were used to maintain anonymity. All participants of the interviews were encouraged but not forced to contribute to the questions. The students and their parents/guardians were informed about the interview time and the set of interview questions were supplied two to three days before, so that the students were made to feel as comfortable about the questions as possible and have time to reflect on some of the points. The interview time for each group of students was approximately 15 minutes and it was expected that the students would be able to answer the questions freely. The interview time interval was taken from their science lesson time only so there was no disruption to their other subjects. The interview room was a quiet space and the room was likely adjoined to the laboratory where the students attended their science class. As is the accepted practice with this type of research, on the day of the interviews the students were asked if they were comfortable about being interviewed and that they were aware that at any time they could withdraw from the study. A set

of basic questions were asked. There were some more open-ended questions, which could be asked from students who seemed keen to expand on the previous questions for example. The prompts and additional prompting questions of a similar theme were used to ensure questions were fully answered. Students were 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.

1.8 DATA STORAGE

The data collected during this study was stored electronically on the researcher's own computer and could only be accessed by the researcher. On completion of the study the data will be stored on disks in a locked cupboard in the supervisor's office at Curtin University for five years and then erased from the disks.

1.9 CHAPTER SUMMARY

This chapter outlines the intent and format of the thesis. It contains an overview of the work and gives brief descriptions of the methodology and context to which this research is situated in. It makes comment about the current changes to the New Zealand curriculum, some recent national monitoring findings and poses the objectives and questions of this research.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This literature review presents a synopsis, examining six areas relevant to this thesis. All six are pertinent to learning environment research and relate to the research questions in this study. These questions are directly tied with students' perceptions of science learning and how we might make positive changes to their learning.

Section 2.2 looks briefly at the historical changes in education from early times to modern society, following with the implications to science education as the New Zealand economy developed in the 20th century and into the dawn of the 21st century. This is continued with the development of the New Zealand curriculum and the changing role of secondary education with particular reference to secondary science teaching in the 21st century. Over the last 30 years there have been major reforms of the administration of New Zealand schools. These reforms have changed school practices, including curriculum and teaching, in significant ways. The early 2000s also saw a focus on reforming the assessment system in secondary schools with standard based assessment and the renewed interest in raising achievement, particularly at the bottom end. Recently, our Ministry of Education focus has been on reducing disparity particularly with our Māori and Pasifika students. Literacy and numeracy targeted initiatives have also been implemented to raise student achievement since the beginning of 2010. However, the most recent shift in policy and in turn influence to changes in school practice has been the implementation of the 2007 national curriculum. The direction of this national curriculum gives schools and teachers' considerable freedom to make decisions about what aspects of science to be taught and how they should be taught. Perhaps the most striking implication from this direction is that students come to see science as a socially valuable knowledge system (New Zealand Curriculum, 2007). Previously the emphasis of classroom teaching has been on content and outcome based objectives taught largely

by transmission of facts and concepts. This was and perhaps still is generally orchestrated by whole class instruction and science thought of as a body of objective facts. This direction from the NZ curriculum 2007 document has moved to addressing students' key competencies described as "capabilities for living and lifelong living" (NZC, 2007, p. 12) and this linked with an overarching aim called the Nature of science which is described as the "Overarching unifying strand and through this strand, students learn what science is and how scientists work" (NZC, 2007, p. 28). There has also been much rhetoric in the New Zealand education sector over what education should look like to help prepare students for life and work in the 21st century. Increasingly different sets of skills and dispositions are required from employees in work places now. We are told people are increasingly expected to work well in teams and take responsibility for completing parts of a project as well as whole projects. Their strength lies not in following rules and procedures set by others but in creating new ways of doing and perhaps creating new knowledge. The literature and recent discussion surrounding this way of new doing, thinking, and ability to learn together in a group has significance to this particular research with collaborative learning environments in mind.

Section 2.3 aims to clarify the term collaboration, examining how collaboration can enhance learning and exploring how it is managed in classrooms. Further to this, aspects of facilitating collaboration in the science classroom are studied. A range of literature has been studied to analyse the nature of collaborative practice in classrooms.

In Section 2.4, this briefly discusses the highlights and challenges of professional learning with teachers. There has been a strong movement in New Zealand secondary schools for teachers to inquire into their practice using a number of teacher inquiry models and strategies. There are a series of Ministry of Education reports and recent academic literature that have synthesized research into what makes good professional learning and how has it impacted on students. This section will draw on these findings to support effective professional teacher learning in this project.

Section 2.5 is an examination of learning environment literature and corresponding research. This area is particularly important to this thesis due to the evolving

quantitative research around the world which has investigated many classroom environments with diverse cultures. The array of quantitative instruments and spectrum of qualitative student voice have been instrumental to education not just in accurately measuring learning environments but also in how we might be able to make changes to the learning environment. Historically learning environments have been explored since the 1930s when researchers such as Lewin established that the environment and the people in it determine how people behave. Now in the 2010s, learning environments currently use action research methods, in particular the work by Fisher and Fraser, where quantitative instruments delve deeper into students actual and perceived perceptions of their learning environment.

Section 2.6 solely examines the *Constructivist Learning Environment Survey* (CLES), as this is the quantitative instrument used in this research. There is an historical overview of how the CLES has evolved and the significance of the instrument linked with socio-constructivist views of learning in science classrooms.

The final section (2.7) looks at students 'views of the classroom and learning through a qualitative lens. There is a discussion on gender differences with regard to perceptions in science learning. What students see and observe in classrooms has an influence on the way they understand learning, and particularly learning in school. This section explores studies involving different modes of qualitative voice. This study uses student audio interviews and student written responses in conjunction with the CLES data. However, one other qualitative mode is to ask students to draw their learning in the science classroom. In 2005, there was a small UK study of 6-7 year old primary school children. The students were asked to draw what learning looked like in their classroom. Their drawings were analysed by considering the choices and selections that the students had made. When the drawings were observed and interpreted, there was much diversity in the composition and in the separate elements of their images (Lodge, 2007). When asked to draw a process such as learning, as opposed to a teacher or a good learner, the students' choices and selections are especially valid. This is an interesting area of research into interpreting learning environments that this study wanted to explore a little further, particularly, with an opportunity to use a similar methodology, but with older students (13-14 year olds) in their early science experiences at secondary school.

2.2 CURRICULA AND SCIENCE EDUCATION IN EDUCATION

2.2.1 What were the early ideas on science education and how have these developed till now?

Two and half thousand years ago, ancient Greek philosophers, in particular Plato and Socrates, founded the first ideas of the importance of learning and disciplinary knowledge. Chinese Confucius also closely examined the significance of study and ethics in society early on. Plato's intention was to set up a model of education that would build a society where people would be knowledgeable, gain access to information and live freely and safely. He believed through training and developing qualities in people, they would gain the foundations of reason and fairness. He envisaged a society where future rulers and leaders would obtain the skills and academic knowledge to govern successfully. Consequently, Plato could see that the society would be a better place and people would be happier (Gilbert, 2005).

Education became a desired pursuit, particularly scientific knowledge was taught with importance, the education system soon became selective to a few rather than for all people, with teachers having high status in the community. Plato and Socrates ideally envisioned a society with most people thinking independently, questioning physical phenomena, to gathering reasons why abstract concepts such as forces exist. Nevertheless, a hierarchical order evolved with perhaps only a handful of citizens gaining the full benefits of the education.

Now to New Zealand, some two thousand years later and in 1900, most children had access to education in their early years. At this time however, less than 10 percent of New Zealand's population attended a secondary school (Gilbert, 2005). Mass primary school public education was seen as crucial to supply the need for an educated workforce. The 1877 Education Act endeavoured to establish national standards of quality and it also made primary school education compulsory for everyone (from ages 7 to 14 years). It was imperative that people could read, write, perform simple arithmetic and have some basic lessons on how things work. Native schools (for Māori) were established as well as state schools and the Education act of 1867 required English to be the sole language used in the Native schools. The

primary mission of Native schools was to assimilate Māori into European culture. Native schools remained operating until 1969. Primary education was free, due to the passing of the 1877 Education Act, with most students attending school, although there was a portion of rural children who did not, due to their labour being more important on farms. At this time, the country was in the midst of strong economic growth. There were plenty of labouring jobs and practical skilled citizens were needed at once. British immigrants were welcomed to inhabit the islands to help build the country's rapidly growing infrastructure. Those very few students who did stay on to do secondary school, with their parents paying fees, usually continued onto University. However by the 1920s state funded secondary education was implemented to provide the ever expanding industries with skilled workers and so the secondary sector began to grow rapidly. Employees were required to have more than just the basics of reading and writing. In 1944 a document known as the Thomas Report shaped a new plan for secondary education by establishing a broad and compulsory curriculum. By the mid 1950's more specialized science laboratories were being built and there was an expectation that students would receive science lessons in specialised laboratories when attending a secondary school. Science was part of the compulsory school curriculum up to year 10 (14-15 years).

In the 2010s, science remains compulsory up to the end of year 10 and then after this becomes optional (but highly recommended) in most secondary schools in New Zealand. There are also strong signals from the economy and workplace that changes are apparent in what skills and type of knowledge is required for the future work force and citizenship in the 21st century. Two key indicators have emerged from a recent report titled "Looking Ahead: Science Education for the Twenty-First Century" from the Prime Minister's chief science advisor Peter Gluckman in 2010. First, New Zealand requires a portion of young people to train to be employed in a science related profession. The Gluckman report notes, "We must be able to replace and even increase our pool of science and technology professionals" (Bull, Gilbert, Barwick, Hipkins, & Baker, 2010, p. 11). The second indicator which is probably more pertinent to all of society, that is in order to have a healthy democracy we need a population that is informed in science related issues (Bull et al., 2010). These two indicators bring the importance of science education once again into the limelight. Studies such as the NEMP 2007 show that in New Zealand levels of understanding

of and interest in science are not as good as they could be with a particular widening gap of underachievement of NZ Māori and Pasifika students compared with NZ European students. Evidence from the 2006 Programme for International Student Assessment (PISA) also indicates that New Zealand's 15 year olds are well above the Organisation for Economic Co-operation and Development (OECD) mean. However, further evidence from PISA suggests that the top students do very well but there is a large group of students who do poorly. Furthermore, New Zealand has one of the greatest spreads of achievement of all participating nations (Bull et al., 2010). Key findings from the 2006 PISA Attitudes to engagement with science by ethnic grouping assessment, also revealed that Māori students were the least positive in their views on engagement with science, they were least likely, compared to NZ European, Pasifika and Asian students to have high self belief in science, and were least likely to express a high value of science, both generally and personally (Ministry of Education, 2006).

These bring our attention to what is actually happening in New Zealand science classrooms and are there further opportunities to explore differences in student perceptions with particular attention to ethnic and gender differences? What is the nature of teaching practice in secondary science classrooms at the junior levels? This thesis uses the CLES "Constructivist Learning Environment Survey" as a quantitative instrument to address the first question and provide a further probe into how science is taught. The CLES is discussed further in section 4 of this chapter. In terms of what has been taught and currently the shape of the curriculum in terms of science teaching legalization section 2.2.2 outlines this as follows.

2.2.2 How has the science curriculum in New Zealand developed?

Curriculum change has been a feature of the New Zealand education landscape for some years. The last five years in particular have been a period of planning and decision making by schools since the release of the 2007 New Zealand curriculum document.

The 1980s saw major reform in New Zealand education. The government called for a review of the curriculum, and for the first time the opinions and aspirations of the

whole community were collected. The school curriculum was seen as requiring updating and there was an opportunity for all to contribute. All sectors of the community were sought (Bell, 1987) including Māori. However, the public's ideas were overshadowed by two significant reports released in the late 1980s, Administering for Excellence (*The Picot report*) and *Tomorrow's schools*. The focus was on administration rather than curriculum changes (Gilbert, 2005) and schools were to be governed by boards of trustees. Over this time the science curriculum for years 9-11 secondary students being used by teachers, was a 21-page booklet *Science: syllabus and explanatory notes. Forms III to IV* (Department of Education, 1967). Coincidently the government replaced the department of education with a ministry in 1989. There was another 56-page booklet published in 1978 entitled *Science Forms 1-4 Draft syllabus and Guide* for year 7-10 students that was also being used to steer teachers delivering science lessons at the younger levels. This booklet did contain lists of "Interests and attitudes", "Process skills" and "Knowledge and Concept Development". However, the main focus of both documents was to detail the science content to be covered at each level.

In 1993, a stand-alone booklet titled *Science in the New Zealand Curriculum* was published by the Ministry of Education for all schools. It was divided into eight cognitive levels of understanding, with level 8 being the level expected at year 13 (the final year at secondary school in New Zealand) and level one linked with the cognitive understandings expected at new entrant classes and years 1-2. However these eight levels of cognitive understanding could have any student age associated with them. The subject of Science was divided into six strands. "Making sense of the Physical World", "Making sense of the Material world", "Making sense of the Living world", "Making sense of Planet Earth and Beyond" replaced the terms Physics, Chemistry, Biology and Geology/Astronomy, respectively. These were called the contextual strands and were generally expected to be covered by the teacher in a balanced way over the school year or several years depending on the particular year group they were teaching. The other additional two strands were called the integrating strands, they were "Making sense of Science and its relationship to Technology" and "Developing Scientific skills and attitudes" These integrating strands were perhaps the first steps into how we could approach science learning and teaching in a real context but with the emphasis on skills and socio

scientific views connected with technology. The two integrating strands were expected to be "woven" into all teaching and learning of the contextual strands. This was definitely a different direction and perhaps a different way of delivery, something that may have been assumed by many teachers, but not actually realized and put into their day to day practice. Considering scientific skills and competencies, such as self-management and cooperative skills, while teaching scientific knowledge was a theme that ran through the document's pages with many examples of "Possible learning experiences" at each of the eight levels. This was the other pertinent direction that this 1993 curriculum proceeded to help schools address. The idea of science education being *learner* centred rather than *knowledge* centred. The examples of learning experiences steered the way from a transmission of facts and knowledge to what would be an appropriate context suitable for the students? The lists of "Possible learning experiences" kept the focus on the engagement of the student and the actuality of the learner. The examples also provided practical and tangible experiences so that the teacher could plan and implement them into classroom activities.

Nevertheless, the other major component to the 1993 science curriculum was the "Achievement objectives" at each level. This was a list of scientific concepts and knowledge that was expected to be learnt by the student at each contextual strand. The idea was that teachers were to adhere to this schedule of outcomes, so that their students would have a foundation of knowledge and hence the students could move onto the next level, having assimilated the knowledge. The result was most science teaching schemes in that era were dominated by lists of objectives. The teacher could tick off the objectives as they taught the program in an ordered fashion, and this process satisfied school and Ministry of Education attestations. The intention of the curriculum was perhaps to steer classroom learning using the rich contexts of the real world with the integrated strands in mind. And on observation of some science classrooms and departments, one could see this inference emerging. Units of work or topics were titled with contexts rather than specific science concepts for example "Kitchen chaos" rather than "Acids and bases" and "Emergency clinic" rather than "The human body". The topics certainly had appropriate links to the real world and the titles of the topics had closer links to the student world and television programs. However, what developed was that many science departments interpreted the

"Achievement objectives" as teaching outcomes and their corresponding junior assessments were designed to test whether students had attained these outcomes. The teaching schemes predominantly remained, as a list of discrete concepts to be taught and things to do. The aspects of addressing scientific skills and learner dispositions were somewhat overlooked. At that time the use of collaborative assessment, peer assessment and teachers assessing attributes of students solving problems together was still at its infancy. From 1996, there was the beginning of some research into collaborative assessment called COLA "Cooperative learning and assessment" by Dr. Paul Lowe at Morrinsville College in the Waikato region of the North Island (Lowe, 2004).

A review of the curriculum was undertaken in the years 2000-02 with a widely represented reference group that included trials in schools, national and international research oversaw the development phase. In 2006, a draft version was released for consultation. The 2007 final version introduces a theme of a changing society and an associated response from schools and teachers to make educational changes. Karen Sewell, the secretary for Education states this in the foreword "Our population has become increasingly diverse, technologies are more sophisticated, and the demands of the workplace are more complex. Our education system must respond to these and the other challenges of our times" (Ministry of Education, 2007, p. 4).

From the release of the final document of the New Zealand curriculum (2007) and active professional development in schools since then, the implementation of the document has made an impact on schools and teachers. It has been seen, as acting as a catalyst for starting professional conversations to create effective learning environments for students (Cowie, Hipkins, Keown & Boyd, 2011).

In 2009 through to 2010, a research project led by the New Zealand Council for Educational Research (NZCER) and the University of Waikato, titled the "Curriculum Implementation Exploratory Studies" (CIES), tracked 29 schools across New Zealand, in two stages (included Primary and Secondary schools). It began to explore how the new curriculum (particularly the "front end" of the document) was having an effect on schools, with early adopter schools. By "early adopter" this term was used to indicate schools that were known to have begun exploring and giving

effect to the curriculum. The summary report of the CIES project concludes that the "NZC did provide a really positive boost for curriculum change" (Cowie et al., 2011, p. 3). Key findings of the study showed that these schools were overall, beginning to create a sense of shared purpose amongst staff using the vision and values found on pages 8-10 of the document. The NZC 2007 assisted in the teacher conversations around a shared vision for learners and learning. Schools showed they were making more space for students to be actively involved in making learning decisions. Across all the schools there was a trend where students were actively more involved in student-led inquiry approaches and a new focus on learning to learn that linked with the key competencies on pages 12-13 (Cowie et al., 2011). Finally, the summary report describes that there was a strengthened sense of collective responsibility for student achievement with particular mention of heightened awareness of taking responsibility for Māori student achievement.

There was an investment from the Ministry of Education into the professional development for teachers over the years 2007 to 2009 in conjunction with the release of the NZC 2007. Schools were given financial support to release teachers in specific professional learning curriculum programmes and there were also large scale regional school one day closures. Each teacher was expected to have a copy of the document, and these were freely sent to all schools. Teacher release time was allocated to all schools in the country to provide the opportunity for teachers to discuss four main aspects: principles, values, key competencies and pedagogy. There was particular emphasis on the professional development for teachers, with regard to the first 44 pages of the document, which contained these four aspects rather than subject specific details which were at the back of the booklet.

2.2.3 The 2007 New Zealand Curriculum- Key Competencies and the Nature of Science

The current curriculum for New Zealand schools is described in a 65-page booklet, which has a format of eight fold-out pages (corresponding to the eight cognitive levels of understanding) and which examine eight learning areas, one of those being science. Gone are the separate, specialized booklets for each of the subjects, here in this document they are described side by side at each of the levels. At the front of the

document there are pages discussing: “Vision - what we want for young people; Principles - foundations of curriculum decision making; Values - to be encouraged, modelled and explored; and the Key competencies - capabilities for living and lifelong learning”.

At the back, in the fold out science parts there is an area at the top, titled Nature of Science - the overarching strand to the other four contextual strands: Living World, Planet Earth and Beyond, Physical World and Material World. The two integrated science strands from the 1993 curriculum have gone and the Nature of science strand has most likely replaced and further developed the concepts of skills and making sense of science of the 1993 integrated strands. Technology is now a separate learning area and does not appear to be linked with science in the document.

The Nature of Science splits into four ideas: “Understanding about science, “Investigating in science”, “Communicating in science” and “Participating and Contributing” (NZC, 2007). They are described by the following ideas: students learn what science is and how scientists work. They come to appreciate that science has a foundation of knowledge but this knowledge is constantly re-examined and investigated, to build on with new evidence. Students are also expected to see that science is socially connected with real scientists and real life. This Nature of science strand is quite a shift from the skills and attitudes strand in the previous document. The significance of the concept, science being a “socially valuable knowledge system” (NZC, 2007, p. 28) carves a different sphere for teachers and students to operate in. The subject of science is no longer a bunch of finite facts and some cooperative skills thrown in to learn about. As Barker (2008) points out social constructivist concepts have been influential in curricula around the world. In New Zealand, the Nature of Science strands bear witness to this. There is prominence in the teacher knowing the learner, the student’s cultural perspective to learning, the socio implications linked with conceptual understanding and the teacher facilitating group work. “The jargon of social constructivism …. has entered the private vocabulary, and the public practice, of many teachers” (Barker, 2008, p. 31). However, Barker (2008) also enlightens that curriculum documents are rather cautious about overtly labelling social constructivist or other learning theories within

the literature. Most likely so the documents are not criticized in taking a stance in a particular premise and fear of the literature becoming outmoded.

The contexts for learning in the curriculum statements are usually taken to mean the real-life world of the student. The four contextual strands are positioned below the Nature of science in the curriculum document, highlighting that the Nature of science is the unifying theme for all of the contextual strands. Each contextual strand is defined by brief statements such as at level 5: "Living World, students will: Life processes, identify the key structural features and functions involved in the life processes of plants and animals". These are explained as achievement objectives.

2.2.4 The nature of the curriculum taught in New Zealand Year 9 and 10 science classes

This section describes the practical nature of how science is taught in classes and some brief comments about science assessment at Years 9 and 10. This is with particular reference to the Waikato and Bay of Plenty Regions in which this research is situated. As explained earlier, the NZ curriculum is separated into eight learning areas with science being one of these. In Years 9 and 10, students could be learning at any of the eight levels associated with science. However, generally students would be in the range of levels three to five depending on their individual understanding and content knowledge. At Year 9, the students' level of science understanding and associated competencies are very much linked with what they bring from intermediate and primary schools; Year 9 being the first year of secondary school in New Zealand.

Teachers are expected by the Ministry of Education to cover the four contextual strands outlined earlier, however they have choice and freedom over what topics can be covered. A science topic could embrace one or more of the contextual strands. For example, the Living World and the Material World contextual strands and some of the associated learning objectives could be addressed in one topic such as Plants. A topic usually takes four to five weeks and students could use a range of resources and text books. Most but not all classes have access to the internet to access information for projects. Computers are used by students either in small pods either in the science

laboratory, close by in a connecting room to the science laboratory or in a specialised computer room with a large number of machines connected to the internet.

In Years 9 and 10, teachers have autonomy over what topics can be taught and the current curriculum supports the individuality of each school and how the students might learn about relevant topics associated with their particular school's geography and location. Hence schools have a wide range of what topics are taught in the science programs and there can be flexibility within science departments in the design of them. Some use text books as a framework for reading and exercises over the year, other schools adopt their own booklets that they have designed to cover individual topics. The flexibility of these kinds of science programs would be apparent in the classes in this study.

Formal qualifications in New Zealand begin in Year 11, so in the Years 9 and 10 there is greater freedom for teachers and schools to design their own junior assessment programme. Generally, most classes would sit a one to two hour exam at the end of Year 10 and this exam usually would be put together by the teaching staff or HOD science at the school not from an outside agency. The rest of the assessment at Years 9 and 10 would be made up of smaller assessments such as project work, practical tests and topic tests. Some of these tests in this study would be collaboratively completed in the student groups. Cooperative Learning Assessment (COLA) has been used in the Waikato and Bay of Plenty regions for some time with support from Dr. Paul Lowe. This type of assessment has been popular with students and teachers alike and has produced successful results in terms of shifting student understanding.

Finally, the Nature of Science strand described earlier is closely associated with much of the design of junior science programs. Schools reporting on student assessment base their judgement not only on content knowledge but also on the Nature of Science strand. Teachers are encouraged to report not only on the knowledge of science but also students' understanding of social action in science with attention to the application of science concepts. This shift in the style of school reporting and student assessment, particularly with the links with the Nature of Science strand, remains work in progress for most schools.

2.3 COLLABORATIVE LEARNING

2.3.1 Collaboration - What do we mean?

Science laboratories in secondary schools are usually crowded and busy places, so potentially very social. Yet when it comes to observing the teaching methods in the classrooms, much of it can be focused on the individual student completing work and whole class instruction, particularly in secondary schools. It's as though the social sphere of thinking and learning is somewhat overlooked, possibly due to the demands of time, assessment protocols or finishing point of work. Science teachers claim to make efforts to enhance collaborative practices when students are doing activities, instructing the students to be in groups or pairs. However, at a closer look, much of the group nature of the work remains individual. What can happen is that there are students usually working towards their individual goals, which other students in the group are replicating to reach the goal. Whereas students who are collaborating, their actions are attuned in order to achieve a shared goal (Watkins, Carnell, & Lodge, 2007). Further to this, students may partake in certain roles within the group, to attain a shared learning goal and generally there is a sense of shared responsibility for the learning. The term "group" used here has the meaning of a pair of students or more working together. We know that communication is a key element for co-operation and collaboration to happen (Brown & Thomson, 2000). Nevertheless, the terms co-operating and collaborating can easily be assumed to mean the same and can at times be loosely discussed, without giving much time to reveal their differences. Students who are actively co-operating, according to Kagan (1992, 1994) six key concepts need to exist, outlined below:

1. Teams of students working together in the classroom, student's sharing resources and equipment such as textbooks and apparatus "Pass the Bunsen burner." "I will get the tongs."
2. Managing cooperation. Seating and space for learners working together.
3. Cooperation, involves continued maintenance and structure from the teacher. Strategies such as team building exercises, rewards and acknowledgement to be used.

4. Cooperative skills modelled and reinforced through role-playing and specific practical tasks.
5. Basic principles: contribution by all, accountability of the individual, equal participation and continuous activity.
6. Structure of the lesson, how concepts are explored and developed rather than content delivered.

Brown and Thomson (2000), two New Zealand researchers, place an importance on teaching the skills of cooperation and establishing a learning environment that is cooperative. They suggest that cooperative learning does not just appear in the classroom and if self- directed responsible life-long learners are our goal, we must ensure we design these strategies into every day classroom activities (Brown & Thomson, 2000). Their studies examine both international and New Zealand ideas on students working together and they base much of their work on the Johnson and Johnson (1994) effective requirements as a basic framework for cooperative learning:

- Sharing a common purpose
- Working together for mutual advantage
- Long term outlook
- Shared identity as a team player and as an individual
- Having a mutual commitment and investment in learning

"Students are often placed in situations where they do not have the skills required for the complex task of working together" (Brown & Thomson, 2000, p. 21)

So these effective requirements were further developed by Brown and Thomson into five essential ideas as the following acronym PIGSF (Pigs Fly):

P Positive interdependence
I Individual accountability
G Group and individual reflection
S Small group skills

F Face to face interaction

The idea of interdependence is significant for success and fulfilment of the whole group. Sometimes when students are asked to work together to complete a task, they may be unfamiliar in taking on roles to complete the work. Perhaps in the past, students have been urged to help each other however real success occurs from the group to meet the success criteria together, not individually (Brown & Thomson, 2000).

Student accountability is an issue that is repeatedly discussed in New Zealand secondary schools. At times teachers can forget to see how accountability is linked with care and respect. There are expectations and responsibilities for students to be active in making decisions in their learning and choice of subjects and extra-curricular activities. However, in order to do this, students need to feel safe at school and in the classroom. Not just in terms of physical safety, but holistically, in all levels of personal safety and well being. Student confidence in speaking up and having a say in what they learn and how they learn directly links with expectations from teachers. The Māori concept of *Ako* in the Ka Hikitia strategy (2008-2012) in New Zealand schools frames this idea of teaching-wellbeing in two aspects. The relationship between the teacher and the learner is of crucial significance to better learning; and the process of the valuing of the student, where they come from and the building on what they bring with them is critical for improvement (Ministry of Education, 2008).

Team reflection describes the purpose of evaluating how students work together and what can be done to improve strategies in working together. Setting new goals helps in moving forward and maintaining a focus to the learning.

Small group skills and face-to-face interaction are particularly important in developing complex thinking. Complex learning thoughts can emerge and be developed by simple tasks. Skills can be employed to aid this by working on projects such as e.g. cutting and gluing cardboard/paper to construct a model, skimming and scanning of internet information to solve a problem or answer a question, using a movie camera in a role-play situation, writing an interview with

worthwhile questions. Some of these skills maybe somewhat basic procedural steps but can develop into complex learning connections. Examples: selection and choice of models of construction of bridges or houses, selection of variables in fair testing, writing questions in a food-exercise survey.

Facing one another and being in a learning space with others are important and favourable conditions for more effective learning (Brown & Thomson, 2000).

Watkins, Carnell and Lodge (2007) highlight two main characteristics of their understanding of collaboration:

- While collaborating something new is generated that could not have been produced otherwise.
- Collaboration transpires when all the members of the group can contribute to a new shared product.

Dewey (1963) explores the essence of the term collaboration further with regard to learning. He maintains that learning and problem solving are not activities that take place in the minds of isolated, autonomous individuals, in contrast they depend on the interaction with others. He saw the activity of problem solving expanding the mind, not the acquiring and storing of existing knowledge. His belief was that it was the growth of the ideas and new concepts through a process of enquiry, usually in dealings with others.

Glasser (1969, 1986) approaches the challenges and failures in classrooms and schools with the solution of learning teams. He was critical of many educational institutions and looked to co-operation and collaboration strategies as a remedy. He based his philosophy on several basic reasons that would motivate students, if they were placed in teams.

- Students would gain a sense of belonging with teacher selection of the group.

- Belonging was the underlying principle of motivation for students to work together.
- A sense of satisfaction would be created from stronger students helping weaker students due to increased friendship coupled with success. Weaker students were satisfied since every little effort increases the opportunity of success.
- Less dependence on teacher, students have more control with their learning.
- Teachers encourage teams to put forward learning evidence rather than test performance to see if ideas have been learned.
- A team provides a framework for the students to operate in.

So in summary, we can see that when collaboration takes place, from the studies discussed, it can help learners take the opportunity to explain their *meaning- making* to each other. Their learning can become richer and deeper because of their interaction. The act of having to make sense to a peer challenges the learner to illuminate and commune in such a way that their own learning is enhanced (Watkins, Carnell & Lodge, 2007). Hence, the process of an exchange of ideas and the chance of expressing opinion can create the opportunity of acknowledging other learners' views. It is interesting to note, some researchers focus on the significance of collaboration creating something new, for example a shared new product, and others celebrate the process of collaboration being the important factor of new learning. This idea leads us into the next section on learning constructively in the science classroom and how does that link with collaborative learning.

2.3.2 Collaborative and Constructivist learning- What's the link?

The constructivist view of learning acknowledges students making sense of the world in relation to their knowledge that they consider and construct. Skamp (1998) considers this learning viewpoint by suggesting that students construct rather than absorb new ideas when learning takes place. He states that: "Learning is not a transmission of knowledge from the head of the teacher (or another source, such as textbook or a web page) to the head of the learner" (Skamp, 1998, p. 8).

The social constructivist learning theory has emphasis on social interaction and collaborative interdependence. These ideas about learning are derived from the work of psychologist Vygotsky (1986) where learning conceptions exist in a 'social plane' and where talking and the socio-exchange of ideas are critical factors for learning to take place. The term social constructivism recognizes the significance of social influence rather than just learning being done by the individual. Duit and Treagust (1998) also recognize the importance of the links between the everyday world of the learner and the science world at school. The context of learning can shift for the learner; the learning can be situated at home and at a school. This change of cultures has implications for the learner with regard to the use of language and cultural response. Duit and Treagust (1998) explore this further in saying that teachers have a role to play in supporting the bridge between the two cultures. It is this socio emphasis associated with collaboration that can take place in a science lesson. Talk is a human process (Watkins et al., 2007) and learning is centred around making sense of the world, which students create and exchange through use of language. There is a crucial step in collaboration when learners explain their meaning to each other, their learning is richer and deeper. The actual act of having to explain ideas to another person has the potential to confront the learner to illuminate and converse in such a way that their own learning is enhanced.

Another dimension to consider in socio-constructivist environments is how learners manage with different conceptions being discussed. These could be conflicting (maybe even incorrect) ideas related to the same activity such as the description of forces on a tennis ball when hit by a tennis racquet. Students working in groups are required to cope with divergent ideas from other members of the group. The reconciliation of conflicting ideas maybe a significant process involved in collaborative learning. So the links between classroom collaboration and constructivist teaching approaches stand out as inexplicitly joined. Two points stand out here:

- Students construct meaning through communication and comparison
- Students are required to reconcile different viewpoints that may emerge.

2.3.3 Facilitating collaboration in the science classroom

There are no grounds to presume that organizing students into groups and giving them a joint task will necessarily escort them to collaborating. Students' previous teachers and learning experiences and their surrounding culture at school and at home may not have equipped them well. The interaction between the learners could be highly competitive and disconnected. Hence, the strongest influences for optimizing collaboration are: the nature of interaction, the design of the task that is encouraged and the building of collaborative structures (Watkins et al., 2007).

- Student to student interactions and patterns of these interactions are not a permanent situation and can be changed by teachers. The promotion of collaborative interaction, thinking collectively and acting supportively can be orchestrated by teachers. With particular reference to 13-14 year old students, who can suffer from blurting out derogatory statements which could hinder the process of collaboration! Many classroom discussions may wish to have a framework of expectations of type and form of positive classroom interactions. For example, students may need to be reminded of etiquette and respect when another student is talking. Teachers can facilitate what skills can be used for students in helping, summing up, highlighting, and improving other students learning. These teacher facilitation strategies are directly linked with teachers' pedagogical content knowledge. Teachers having knowledge in dealing with misunderstandings when they arise, and how they can anticipate learner interaction can be beneficial in learning (Timperley & Parr, 2010). Other prompts such as role taking within a group, where the teacher facilitates how different roles can be an effective way for collaboration to occur. For example:

  '*Technician*- a student identified as who gets the equipment, operates the apparatus, for example, managing the test-tubes, camera, stopwatches'.
  '*Researcher*- a student identified as the person who collects the information or data, they may record experimental data into their book or search the internet for information ',

'*Director*- a student identified as the leader or the captain of the team- they may make final decisions about what is going to happen or they may be the key person reporting back to the class about the groups' findings'.

Role facilitation can support students in their interaction between one another and help with sorting out who is going to do what in activities.

- The design of the task has an important influence on whether learners will collaborate with one another. Usually the activity needs to be designed in such a way that it cannot be solved/performed by one individual. All learners, imperatively, in the team are expected to operate together to solve the problem or perform the activity. Hence, the success of the task requires the contribution of many and there must be interdependence between each member (Cohen, 1992).

- Building collaborative structures (Watkins et al., 2007) is a significant key to successful intervention of collaborative learning in classrooms. If we could instantaneously travel to and appear in several junior secondary science laboratories in this moment of time, what would we see as the physical arrangement of tables and science benches? Of course there would be a range of designs and seating arrangements, but a typical plan seen in many local schools where this study is situated, is depicted where rooms have benches facing to the front of the room, and where the teacher is, close to the whiteboard. Most of the seats (sometimes in rows) are positioned so that there is little obstruction in the visual path of whiteboard/screen to and from the students. This kind of seating arrangement may be beneficial for ease of transmission of notes and power-point images, on the other hand this structure can isolate the learner from other learners. The opportunity for students facing one another can be lost. Learners may not be given the opportunity to face one another and see that they are facing other students which are also learning resources, which obviously can enhance collaboration. The other form of collaborative structure is to do with the socio-bridge between the members of a pair or group. The key point here is that pair-work forms the interaction of personal learner thoughts and peer

discussion. The 'Think, Pair Share' (Lyman, 1981) strategy forms the base of this concept. From the development of this pair-work, whole class collaboration can be facilitated. However this is seldom observed in secondary science classrooms, where the norm can be student responses and comments are managed by the teacher in whole class discussion.

2.4 FACILITATING EFFECTIVE PROFESSIONAL LEARNING AND DEVELOPMENT WITH TEACHERS

2.4.1 Professional inquiry into teaching and learning

A key feature of the current New Zealand curriculum is the emphasis on teaching as a process of inquiry. This has been seen as strength (Timperley & Parr, 2010) of the introduced 2007 curriculum and this spotlight on teacher inquest into their own learning has been embraced by some secondary schools. The vast majority of teachers enter the profession with a sense of moral purpose to make a positive difference for students. The intention to evaluate their teaching and perhaps make changes to practice can sometimes be disregarded in a busy teaching program. After the usual initial one year pre-service teacher training in New Zealand, secondary teachers may have limited opportunity in furthering their own personal professional development. Teachers may become professionally isolated and may not be able to have an opportunity to behave as learners too. The process of professional development can be *ad hoc* and at times disconnected with the student learning taking place in the classroom. There are concerns that maybe there has been too much emphasis on working conditions (Hattie, 2005) and maybe a fascination on content management, particularly at the faculty level. In summary, the quality of professional discourse depends very much on the leadership of the school and of the faculty as to the nature and process of the professional learning that can take place.

The focus on effective teacher professional learning is seen as a significant opportunity to make a substantial impact on student learning. Timperley, Wilson, Barrar, and Fung (2007) comment that given the right supportive conditions, teacher learning can dramatically influence overall student outcomes. Their recent findings which are in a synthesis of international research show that through particular

effective professional teacher learning, students can gain a sense of identity and their critical thought to problems can be noticeably enhanced. This best evidence synthesis has encouraged New Zealand schools and teacher educators to explore the key areas of what effective professional learning looks like. It can lead to further investigation of elements that work well and why for student learning and what elements are not working well and why. There have always been opportunities that possible changes to teacher thinking and teaching practice can be explored and discussed, however these research findings offer a robust evaluation of what has been effective in the past and the evidence that informs this. Further development of professional inquiry has been shaped into a model of an inquiry-knowledge cycle where teacher professional change is cyclic and transformative (Timperley et al., 2007). Professional knowledge through this cycle of teacher inquiry is built around the following parts, the initial stage of the knowledge of the learners - what are the students' strengths and needs? the second step is what professional strengths and learning needs are identified by the teachers? Evidence is identified and discussed. A third stage of engagement of leaders and teachers in professional learning experiences is expected. There is a shift to an important engagement phase where students take part in new learning experiences. Then the process moves on to a fifth step where there is teacher reflection on any positive effects made to the changed interventions and the possibility of testing to see if there has been positive impact on student learning, returning to the starting phase of identification of students' learning strengths and needs once again. These stages are re-occurring and form the basis of ongoing evidence-based professional inquiry (Timperley & Parr, 2010).

2.4.2 Elements of professional learning that can impact positively on student outcomes.

The following is a brief summary of the nature of the professional learning that can make a beneficial impact on student outcomes. These understandings come from the work of the New Zealand Ministry of Education and in particular the report *Best evidence synthesis iterations* (Timperley et al., 2007) which has drawn together a large body of research findings in New Zealand and overseas to explain what elements of teacher professional learning and development have made a difference to students.

- A professional learning community of practice where teachers are engaged in learning at some point. An effective professional learning community is defined where teachers have opportunities to process new pedagogical understandings and challenge problematic beliefs. There is usually a focus on analyzing the impact of teaching on student learning. The opportunity for teachers to talk and discuss the ideas on change help in understanding the reasons behind the change (Le Fevre, 2010). Such participation on its own was not associated with change, however all the core studies included some kind of community of practice. The emphasis was on the opportunity to participate rather than the place.

- Teachers have the opportunity to use external expertise to facilitate new learning in a supportive and positive environment. This external expertise was not sufficient, however in many of the studies it was a feature of nearly all the interventions. It is also noted that some interventions, with low or no impact on student outcomes, also involved external experts.
- Facilitation of effective pedagogy situated in relevant science contexts. Teachers were encouraged and assisted to translate theoretical understandings into classroom practice. Integration of sound pedagogical tools linked with science ideas and contexts were shown to make positive changes to student outcomes.

- Time for opportunities to learn was necessary but not sufficient. Professional learning opportunities typically occurred over an extended period of time and involved frequent contact with the provider. However, it was how the time was used; this was more significant than the nature of the provision (for example release from teaching duties).

- Teachers' engagement in learning at some point was more important than initial volunteering. Neither had who initiated the professional learning opportunities nor was whether they were voluntary or compulsory associated with particular outcomes for students. What was more significant was that teachers engaged in the learning process. Volunteering was not a necessary

condition for successful professional development, neither was it a guarantee of change.

- Professional learning goals. In all the selected science interventions, professional learning goals specific to science were explicitly shared with teachers.

2.4.3 Challenges in teacher professional learning

Teachers require active support to make changes to their practice and perhaps even more importantly changes to their beliefs and values. It is not sufficient just to hold high expectations where teachers will intrinsically reflect on their practice and take the associated steps in making a change. Change is a significant aspect of the life of schools (Le Fevre, 2010). There are complex challenges for teachers, and professional learning in schools can be problematic. Sometimes there is a tendency for schools to take on too many initiatives and support can be conflicting. Teachers can become exhausted and disengaged because of lack of vision and planning from school leadership. It is important that teachers are committed and there is "buy in" from both school leadership and classroom teachers. Furthermore, there needs to be a supportive environment where trust and risk taking exists. The following two points illustrate some challenges that can exist in facilitating professional learning.

- There is a challenge of addressing an enactment gap (Schon, 1983) where teachers may struggle to make change to their practice. This challenge can form a dilemma between understanding the reasons that lie behind the learning strategies that are being trialled. "There is a major difference between knowing why and knowing how" (Le Fevre, 2010, p. 80). In some circumstances, teachers have professional learning experiences that show them practical strategies and active teaching mechanisms which they can introduce into their classrooms. This obviously can be very beneficial in an immediate sense, however the necessary reasoning and theoretical understanding regarding why they are introducing these strategies may not be provided. Recently in New Zealand, there are some initiatives that provide plenty of practical strategies for teachers but they can lack the opportunity for

teachers to “chew over” the theoretical understandings that underpin the activities. It is important that professional support incorporates and makes visible the difference between knowing how and knowing why.

In the opposite view, teachers can feel they have gained in-depth theoretical ideas and understood academic literature but do not know how they might actually go about it in their classrooms. For example, teachers may agree in principle with the need to change the way they teach science collaboratively and that they welcome shared control in their classroom. They may see the need to make these changes but are unsure of how to actually implement, on a practical level, the corresponding strategies.

- Building relational trust and at the same time providing an environment where supporting risk taking can be a challenge. Effective change involves risk taking and sometimes a commitment to make a change requires a degree of risk for all concerned. At the same time there needs to be a supportive and positive environment where risk taking is seen as okay and this is acknowledged. If relational trust is low, the nature of professional discourse may appear agreeable on the surface but important challenges tend to be avoided. Teachers can feel vulnerable when taking risks particularly if they are trialling different types of teaching strategies that may have an influence or impact on their colleagues’ practice. High relational trust occurs when it is safe to discuss tough issues and debate issues of importance.

2.5 LEARNING ENVIRONMENTS RESEARCH

Over the last 40 years new instruments for measuring learning environments have quickly evolved. Early on, Moos and Trickett (1974) had begun to focus on student perceptions of their learning environment. Moos centred his projects on learning environments in three dimensions: personal development, relationships and system maintenance and change. His studies involved hospitals, army camps and schools. He posed a number of questions. How well do the people get on with one another? How orderly or innovative is the environment? How is the system maintained? The *Classroom Environment Scale* (CES) was developed (Moos & Trickett, 1987), an

instrument that was made up of nine different scales to measure learning in the school classroom as a whole. It was designed for teacher-centred classrooms and contained scales, such as Teacher Support, Innovation, Teacher Control and Task Orientation.

In the 1960s, a similar assessment tool had been developed involving the Harvard physics project (Walberg & Anderson, 1968) called the *Learning Environment Inventory* (LEI) with scales such as Cohesiveness and Goal Direction. Walberg worked on a model to summarize findings and encapsulate processes of learning. A triangular flow diagram demonstrates how affective behavioural and cognitive learning are influenced by aptitude, instruction and the environment. Walberg described them as causal influences and in the 1980s he spoke of these influences being inter-related with regard to student learning.

It was early on when ideas such as the environment as assessed by a detached observer were considered. This was called "alpha press" as opposed to the environment as observed by those within the environment called "beta press" (Murray, 1938). Stern, Stein, and Bloom (1956) took this further and elaborated on the two themes by focusing on the awareness and insight into the environment from an individual point of view and the perception of the environment shared among the group. Another important development occurred in the late 1980s with a similar theme, with the emphasis on student perception at an individual level rather than as a whole class. Awareness of students' perceptions and their individual role in the classroom were acknowledged (Tobin 1987; Tobin & Gallagher, 1987; Tobin & Malone, 1989). At that time concerns about how students who were more active in discussions and tasks in the classroom tended to be targeted. This could result in undue bias in the instrument for an entire class. In other words, these active members of a class may paint more of a favourable picture and this suggested the importance of developing questionnaires that could measure individual perceptions of classrooms. Furthermore the use of the traditional class form, an instrument that measured perception of the learning environment in the class as a whole was questioned (Fraser & Tobin, 1991). Hence, the developments of personal forms to measure personal perceptions of students' roles in the environment of the classroom (Fraser, Giddings, & McRobbie, 1992).

Concerns about the effectiveness of the learning taking place in science practical environments also were considered (Hodson, 1990; Lazarowitz & Tamir, 1994) and this provided the momentum to design an appropriate instrument to measure the science practical classroom climate at secondary schools, the *Science Laboratory Environment Inventory* (SLEI). There was an actual and a preferred version of a class form and personal form. Scales such as Integration and Open-endedness were addressed. The actual form considered what was actually happening in a realistic sense from the student perspective where as in the preferred form, the items were modified to measure student perspective in an ideal sense or preferred manner. The actual form data could then be compared with the preferred form data and comparative patterns studied.

The *Questionnaire on Teacher Interaction* (QTI) (Wubbels & Brekelmans, 1998; Wubbels & Levy, 1993) which centred around the inter-relationships between teachers and students, and founded in the Netherlands, also adds a powerful measuring device for assessment of leadership, student responsibility and freedom in the learning environment.

Worthwhile attention has been given to the association between the student learning environment and student achievement. It is this link between how students perceive their learning environment and their academic performance that has come under the watchful eye of principals, teachers and academics over the years. Hattie (1987) observed a direct relationship between students positively perceiving their learning environments with students' high performance in exams. Furthermore, a study by Fisher and Fraser (1983) using preferred and actual instruments indicated that the ratio of actual-preferred congruence could be an indicator in predicting student achievement. This poses a suggestion of the potential for implementing changes to the actual learning environment with respect to the students' preferred classroom environment. This is of particular interest to the researcher. The workings of the evaluation of the learning environment and the effect of modifications to that environment are thought provoking and require careful attention.

Four characteristics of the learning environment that have been found to promote cognitive and affective consequences of effective learning are: personalization,

involvement, order and organization, and task orientation. (Fraser, 1994; Fraser, Rennie, & Tobin, 1990; Fraser & Tobin, 1991) These studies have shown that the teacher-student relationship and the student-student relationship are significant factors that can influence student learning. It was the provision of opportunities embracing students' welfare (personalization), the amount of teacher encouragement and supportiveness (involvement), the establishment of an orderly and organized class (order), and the elements of clarity and method of class tasks (task orientation) that can result in creating a powerful classroom culture.

An extensive study in New Zealand directed by the Graham Nuthall Classroom Research Trust supports these four identified characteristics. Here the intention was on how students experience classroom learning activities and how they learn from that experience. Also, how did teachers actually influence student experiences and shape their learning? (Nuthall, 2007). The project looked at why some students learn, and why others do not from the same learning activities. The research was carried out through the use of miniature video cameras mounted on the ceilings in the classrooms, and students and teachers wearing miniature broadcast microphones. Student and teacher voice were recorded. Three primary factors emerged from the findings regarding effective student learning: the differences in background knowledge and in the understandings and misunderstandings that students bring to a task; the power of peer relationships and peer status influencing the learning experiences; and the need for the teacher to constantly monitor what students are or are not learning from their activities and to respond accordingly.

These three factors that have been affirmed from student learning in the New Zealand study connect comfortably with the four revealing characteristics of an effective learning environment noted in the 1990s studies referred to above. The peer relationship factor corresponds to the teacher involvement in the peer culture and addresses the link with care about students' welfare and social growth, which has been represented as personalization (Wahyudi & Treagust, 2003). The explicit link with student background knowledge/conceptual understanding seems aptly connected to the description of involvement-orientation in a task. Furthermore, the association with teacher monitoring/response to student learning appears to be closely related with the idea of the order in the learning environment. These patterns

and interconnections between the two studies seem parallel in many ways, both primarily considering the learning environment.

2.5.1 Quantitative design

When Lewin (1936) tried to verify the learning environment with regard to the parameters of the interaction of the individual and the environment, this was a prominent beginning to specifically measuring a learning environment. The introduction of a formula B=f (P, E), Lewin (1936) recognized the elements of the environment (E) and the person (P) to describe human behaviour (B). This may have influenced a mathematical context to investigating the learning environment. Since Lewin's description, there has been much written comparing the features of quantitative and qualitative analysis with regard to classroom culture.

Conducting research using quantification has significant merits in employing levels of measurement. The comparisons between the essential features of qualitative and quantitative analysis are tabled (Sarantakos, 1993). The aspect of the researcher being somewhat more distant from the respondent and the employment of a deductive approach seems a suitable platform to gather valid quantitative data. Furthermore, the use of a quantitative instrument seems to employ a more objective approach and there can be defined scales to measure the learning environment. Possessing pre-determined scales can guide the project and keep it manageable and focused. The other aspect is reliability of the data in terms of replicating a study, when using a quantitative instrument there is a reasonable amount of confidence that if the study were repeated by the researcher or someone else, similar results would prevail.

The contrasts of quantitative to qualitative suggest that "we must avoid becoming slavishly committed to some particular method" (Shulman, 1988, p. 15). As researchers we must be attentive to "first focus on our problem and its characteristics before we rush to select the appropriate method" (Shulman, 1988, p. 15). This implies the need to consider a variety of methods and together they will build a jigsaw of methodologies that will support the study. For the findings to be credible

the researcher was aware of the method of triangulation where one uses more than one data source to ensure that other perspectives are given in the case or setting.

In the last 30 years, there have been instruments developed for a range of classroom environments, for example, individualized classrooms (Fraser, 1990) and constructivist classrooms (Taylor, Dawson, & Fraser, 1995). One concern that appeared in the studies of the 1980s was that of groups of students who were found to be more directly involved in the classroom discussions than other students who were not so active. This suggested an individualized instrument would be of beneficial value in describing the learning environment. Hence the use of the traditional class form describing the class as a whole could pose a problem with the purpose of measuring the environment through the eyes of an individual student. Also, at this time, the traditional role of the teacher transmitting content knowledge to students was questioned. The theories of behaviourism and constructivism were being discussed and reflected on by teaching practitioners and academics. Teachers can use behaviourist principles for classroom management such as rewards and consequences, but use constructivist principles in learning activities, such as cooperative learning and development time. These influences may have helped pave the way for the designing of different forms of learning environment instruments mentioned earlier. The personal and class forms considered the role of the individual within the class and the class form considered the class as a whole (Fraser, Fisher, & McRobbie, 1996). Additional scales such as Personal Relevance and the promotion of understanding rather than rote learning were shifts in the development of the instruments.

2.5.2 A constructivist model of learning associated with learning environment research

There have been a series of developments in learning theories in science education over the last century. In the 1950s, research published in the USA had a prevailing behaviourist theme. The idea of the learner viewed as adapting to the learning environment and that learning seen largely as a passive process was questioned (Duit & Treagust, 1998). Piaget had a profound influence in the analysis of cognitive development throughout this time and even to this day. He discussed the significance

of the learner developing general cognitive structures to make sense of the experience (Piaget, 1954). There were also concerns from scientists and the general science community in the USA (Duit & Treagust, 1998) about the quality of science education in schools and that young people were not given opportunities in the classrooms to develop their inquiry processes. The successful and creative Sputnik operations from the Russians perhaps prompted the Americans to look at cognitive development in children. It was Ausubel's assimilation theory of learning (Ausubel, 1968) that supported the idea of the learner inventing models, concepts and schemes to make sense of their experiences. That new knowledge interacts with existing relevant concepts and is assimilated into these concepts. The main factor that aided this development of conceptual change was the learner's prior knowledge (Novak, 1978). The next section goes on to describe the Constructivist Learning Environment Survey which was based on the social constructivist theory.

2.6 THE CONSTRUCTIVIST LEARNING ENVIRONMENT SURVEY

The Constructivist Learning Environment Survey (CLES) considers a socio-constructivist model of learning. The constructivist view acknowledges that students make sense of the world in relation to their knowledge that they consider and construct. It encourages students to develop deeper understanding, challenge what they learn and how they learn, see relevance in what they learn, negotiate their learning and reflect on what and how they learn. The CLES questionnaire measures personal relevance, uncertainty, critical voice, shared control and student negotiation. This tool was used not only to measure and quantify student perception but to assist teachers to reflect on their assumptions and support them in making shifts in their teaching practice (Taylor, Fraser & Fisher, 1997). The CLES surveys "What happens in my science classroom?" -Student Actual Form and "What I wish would happen in my science classroom?" -Student Preferred Form were pertinent tools for teachers to measure learning climate in a constructivist view in a science classroom.

The first version of the CLES was launched in 1991 (Taylor & Fraser, 1991) and was compatible with von Glasersfeld's (1981, 1988) viewpoint of *radical constructivism.* The intention of the CLES was to measure the students' perception of their learning environment in a personal form. Three key themes that were focused upon in the

instrument: the degree to which the learner used prior knowledge and reflected on their prior knowledge; the degree to which the student had the freedom and autonomy in learning; and thirdly, the degree to which the student had the opportunity to negotiate their understanding with their peers.

In 1997, revised versions of the CLES (Taylor et al., 1997; Taylor, Fraser, & Fisher, 1997) were developed from the initial version. The three themes were refined, based on the original version (Taylor & Fraser, 1991) and they also embraced the ideas of critical constructivism (Taylor & Campbell-Williams, 1993). These modified versions adopted five key dimensions of a critical constructivist learning environment from the learners' perspective. The key elements measured were: how much relevance is there with the world outside of school and within the learning classroom; how much empowerment the student gains to express issues regarding teaching and learning; how much control is shared between the teacher and the student and the meta-cognitive awareness of the student; how much engagement and interaction between their peers is there to improve understanding; and the extent to which science is viewed as ever changing (Taylor et al., 1995; Taylor et al,1997).

The CLES was available in two forms: the Actual and the Preferred (Taylor et al., 1995). The actual form considered the learning environment as it were by the student or perceived by the student, the preferred form considered what environment was favoured by the student. The preferred form identified the key elements as goals and value orientations (Fraser, 1998). The preferred form had the same five elements (scales) and the same number of items but the wording was slightly changed to imply the ideal or the preferred environment. For example, the title of the preferred form was worded with "What I wish would happen in my science classroom" rather than "What happens in my science classroom" so each item of the preferred form had "In this class I wish that…." Each form contained 30 items altogether with five scales and six items to each scale. The scales offered a five point range with alternative responses such as almost always, often, sometimes, seldom and almost never. There were directions of the purpose of the questionnaire and how to answer each question on the front page of each of the forms.

The CLES has been validated and used in various studies in different countries (e.g., Churach & Fisher, 1999; Stolarchuk & Fisher, 2001). The CLES has been translated and adjusted to accommodate specific situations in both English and non English speaking countries for example the Korean version (Kim, Fisher, & Fraser, 1999) and the online version or the Constructivist On-line Learning Environment Survey (Taylor & Maor, 2000). The new CLES has 25 items with 5 items for each of the 5 scales. The scales of this version of the CLES are listed as follows (Taylor et al., 1997):

Personal relevance: titled as "Learning about the world". This focuses on the extent to which school science is relevant to students' out-of- school experiences.

Uncertainty: titled as "Learning about science". This assesses the extent to which opportunities are provided for students to experience that scientific knowledge is evolving and culturally and socially determined.

Critical voice: titled as "Learning to speak out". This focuses on the extent to which students feel that it is legitimate and beneficial to question the teachers' pedagogical plans and methods.

Shared control: titled as "Learning to learn". This is the extent in which students share with the teacher control for the design and management of the learning activities, assessment criteria and social norms of the classroom.

Student negotiation: titled as "Learning to communicate". This is the extent to which students have opportunities to explain and justify their ideas and to test the viability of their own and other students' ideas.

2.7 LEARNERS' VIEWS OF THE CLASSROOM AND LEARNING - A QUALITATIVE LENS

According to Erickson (1998) the crucial problem for the qualitative researcher was determining the 'qualities' of social action and meaning. The purpose of doing research was to pay close attention to what we see and hear. Furthermore, that

research is an aspect of searching for details and composing strategies to collect data. Erickson pointed out that framing questions is a particularly important aspect of a researcher's project. Having a variety of data collected will allow the learning environment to be described from different angles and perhaps through different lenses. The issues and challenges of asking versus watching were discussed (Erickson, 1998). Furthermore, the undertaking of asking is possibly more intrusive than watching. A suggested method or ideal process could be a building up of repeated observation and interview approaches (Erickson, 1998).

For an effective data collection design like that discussed by Erickson (1998), this research is required to consider a number of different sources of data. The quantitative aspect should be judiciously supported by a range of observation and interviewing techniques. To reveal credible conclusions from the study the researcher was aware that there needs to be cross-checking and confirmation using qualitative voice. A plan of the methods used in this study was an important initial step to gain trustworthy evidence and establish valid patterns. In addition to this, the plan of qualitative research begins with questions based on the participants' environment in their own terms (Janesick, 1994). Hence, this implies that qualitative research is carried out in the so called normal conditions or naturalistic setting of the participant.

Making sense of what students have to say has been the central theme in the recent Te Kotahitanga research study in New Zealand (Bishop & Berryman, 2006). The aim of the project has been to improve the educational achievement of Māori students in mainstream classrooms. While it has been usual for educational researchers to ask teachers, principals and parents about student education it has been unusual to question the young students themselves about their own understanding of their classroom and general school experiences. Bishop and Berryman (2006) also comment that in the past it has been even more atypical to use these young people's understandings as the basis for changing educational practice. One of the features is the attention it pays to what Māori students have to say about their experience at school. Here, describing the learning environment has been valuable in assisting teachers to improve and reflect on their practice using qualitative voice. The other aspect that appears to be a significant theme drawn from Te Kotahitanga project is the awareness of the cultural sensitivity in conducting a project in a New Zealand

school with both Māori and European students. The narratives from the students are pertinent reminders of the importance of gathering qualitative data with a discreet and ethical approach. Schools and students have remained anonymous throughout the Te Kotahitanga research project which began in 2001 and this advocates how important are the ethical responsibilities of the researcher. Written permission, privacy and confidentiality are of significant importance in the conduct of the proposed study. These aspects encourage the researcher to be mindful of his approach to this study and to take into account the ethical and cultural protocols of a study in a school and classroom context.

2.7.1 Student's views of learning as drawings

"What students see in classrooms has an influence on the way they understand learning and especially learning in school" (Watkins et al., 2007, p. 27) and one way to examine these comprehensions is to invite students to draw learning. However, learning is not an object but a process and this can pose a challenge to students when asked to draw the learning in their classroom. The test in drawing a process such as learning involves thinking about abstract concepts. As Sarason (2004) notes, the term 'learning' is not like the words boat or water, or rocket, which have visible, concrete meaning. In making these pictures, students do not merely represent what they see, but they do consider aspects, like for example, their position in the classroom, the positions and images of their peers, the position, size and image of the teacher, the physical nature of the classroom including what is written on the whiteboard, the cultural images, scientific contexts, social interactions and sometimes they include speech bubbles with written words describing their thinking.

In a three year study called *Regarding Learning* in the United Kingdom, Caroline Lodge undertook research in a primary classroom in an east London school (Lodge, 2007). She suggested that discussion and analysis of student drawings of learning may support teachers in their pursuit of understanding what children see as learning. Lodge wanted to follow the idea of how we could make better sense of images of learning which she understood as influenced by conceptions of learning. It was also suggested that we must be careful in making assumptions that as teachers, we know how a young person views their learning or that a class of students share a universal

view of it. There were 23 six to seven year-old children who attended the class and Lodge requested that the students be allowed to draw and take photographs of the learning in their classroom. This was over a period from years 2003-2004. In the analysis of the drawings, Lodge (2007) commented there was an enormous range of composition in all the drawings, just in the one classroom. Some students placed the teacher as the key figure in their drawing, perhaps suggesting a dependence or reliance on the teacher for learning; others placed themselves at the centre with no teacher illustrated. One student situated their peers closely in their drawing with themselves and elaborately illustrated the activity they were performing. Lodge draws together the important messages from the study, suggesting that the talk about the drawings can provide a significant shared exploration between student and teacher with regard to learning.

Others who have used children's drawings to investigate their understandings of learning agree that "drawings are a form of text, and as such, they can be *read*" (Weber & Mitchell, 1996, p. 303). Some writers argue that the visual picture of the learning taking place can be translated and analyzed in a similar way to text information. This can be done through an evaluation of the choices that the student defines in the picture, in perhaps the relative positioning of students and the teacher, the significance of composition using size and shape of objects, repetitions that appear in the illustration or clichés represented about teachers. It is understood that drawing is much more than a simple representation of what one sees. The act of drawing and the production of a visual summary of experience can be a powerful mechanism in making sense of the experience. Milne (2008) assures us that children use drawing to grapple with meaning and purpose of their lives. It is acknowledged that movement and particularly the concept of learning can be challenging concepts to represent in static two-dimensional pictures (Milne, 2008). However what clearly has been revealed is that drawing can express concepts that may not be easily put into words. This intuitive dimension, the sub conscious, the not–yet-spoken realm of drawing (Lodge, 2007) can be such important sense making for children.

These findings from the students' drawings return this literature review to the critical aspect of learning situated in the classroom. The following are questions that provide a framework for a final discussion:

What does learning look like for the student?

What is effective learning?

In particular to the two research questions in this thesis:

What are students' attitudes and perceptions of their experiences in year 9 and 10 science?

How could the learning environment be changed to improve students' attitudes and perceptions?

To consider these questions and identify situations how students learn best, some examples are explained in the following. Watkins et al. (2007) describes teachers' understandings about effective learning taking place in their classrooms. The aspects of students taking responsibility of their own learning, when they see themselves as successful learners, when students are actively engaged and the situation when people are willing to be vulnerable were all identified as possible traits of effective learning in the classroom. One specific aspect that was identified as not required, was the idea that the teacher does not need to offer knowledge to students. These elements help make up a bigger representation of the ideal learning environment and the different views of effective learning that exist around us. It was the significance of the discussion and reflection around the concept effective learning that seemed to be something that could be overlooked and rarely analyzed by teachers as Watkins et al. (2007) point out. Three models of learning are summarized in their findings, these are key elements that try to describe and compare the differences:

Models of learning

- Reception - involved with quantity, facts and skills and this assumes a transmission of knowledge from an external source such as a teacher.
- Construction - involved with the learner constructing meaning through discussion, discovery, making connections and making sense.

- Co-construction - involved with the learner constructing meaning through interaction and collaboration with others, particularly via dialogue.

Watkins et al. (2007) emphasize that these models are not just established in a wealth of literature but they are found in everyday classroom discussions and in particular reference to the students' drawings of their learning researched by Lodge (2007).

2.7.2 Learners' views - Gender differences?

Ferguson and Fraser (1998) have argued that there are changing students perceptions of science learning environments during the transition from primary school to secondary school. They note the effect of gender differences particularly to attitudes towards science learning in early secondary science lessons were measured. When one adds Terwel, Brekelmans, Wubbels, & van den Eden (1994); Fisher, Fraser, & Rickards (1997) findings that experiences of students in classrooms may in fact lead to female students developing persistently negative attitudes. We have an interesting picture developing where the quantitative studies have revealed some degree of variance of perception and attitude with regard to gender. Cotterell (1992) also claimed that the relative change in school size might be an important factor in changing student perception when students move from primary school to secondary school.

However, qualitative data collected from these studies suggested that the boys and girls had different priorities when describing positive attributes about the learning environment with the girls placing more importance on relationships within the school contexts, both with peers and teachers. The boys discussed their interest in the equipment, laboratory facilities and the type of science experiences. Teacher relationships were not seen as significant for the boys as did the girls. Boys saw only peer relationships as important when they were allowed for specific shared activities.

Drawing on the work undertaken by Gilbert (2005) there are some recent emerging trends in both female and male engagement in science lessons or rather lack of engagement that need to be considered. She also suggests that the more adventurous male students have started to vacate the subjects of biology and chemistry to chase

the greater rewards to be found in the entrepreneurial and cutting-edge areas of knowledge development, such as ICT. She also argues the issues of student gender and identity focusing on concerns about girls' participation in the fields of science and technology. There are cultural stereotypes in New Zealand about gender that have an impact on students' career aspirations and this has an effect on student motivation and perception in science learning. One of the reasons young people, especially girls, are reluctant to participate in the physical sciences is because they often perceive identities of engineers and physicists as incongruent with their own.

Bolstad and Hipkins (2009) have suggested that particular kinds of classroom teaching practices could enhance girls' engagement and perhaps encourage a feeling of increased belonging in the science learning environment. They include some examples:

- Low levels of competitiveness and of drill and practice
- High levels of teacher attention to all students including the development of positive self-image
- The use of real-life materials that cater for the specific interests and experiences of girls

In summary, there is a considerable body of research that suggests that there are definite gender differences in student perception and attitude to science, particularly when students enter the junior levels of secondary school. This time also marks a period of significant change in the students' lives, which may also influence their attitudes. In discussions of the role of gender in young people's interest in science, it is important not to stereotype and assume that certain classroom approaches and practices will appeal to all girls or all boys.

2.7.3 Learners' views - Communality and differences between attitude and perceptions of the learning environment.

There is a history of measuring student attitudes going back to the work by Dainton (1968). Here attitudes looked at motivation towards science lessons and there was concern that some children were not enjoying science activities in the classroom. Gardner (1975) also made the distinction between "attitude towards science" and

"scientific attitude". As mentioned earlier the research by Walberg and Anderson (1968) was also seen by many as a first learning environment study showing that equity of the class members and the relationships between them were significant predictors of learning success. By 1986, there were a growing number of learning environment instruments measuring student attitudes in science lessons. Researchers were well aware of the relationships between classroom environment and attitude, efficacy and outcome.

However, what are the differences between attitude and perception? Shrigley (1983) maintains that attitude is central to human activity describing it as what students bring to a situation. These feelings could be preconceived or even assumptions that could be learned as part of culture. Shrigley (1988) suggested that feelings are central to attitudes towards science or toward a particular scientific concept or phenomenon. Key elements describing the attitude concept include the involvement of cognition, that attitudes predict behaviour, social influences of others affect attitudes and attitudes are evaluative (Shrigley, 1983, p.438). However, according to Saks and Johns (1997) the concept of perception is the human process of interpreting a situation. In order to represent and understand the learning environment student perception is shaped by learning, memory and expectation. Perception is described as the ability to understand and when students encounter experiences they can use informational cues to help them perceive the situation. These are often influenced by senses and memory of smells, images, sounds etc. The dependence on experience, motivational state and emotional state are factors that contribute to both attitude and perception and hence there is common ground between both terms.

The CLES is a quantitative questionnaire designed to measure the constructivist view of the classroom (Taylor, Dawson, & Fraser, 1995; Taylor, Fraser, & Fisher, 1997). It investigates how a classroom's environment fits with the epistemology of constructivism. The instrument uses five scales that measure students' perceptions of the extent to which certain psychosocial factors (Personal Relevance, Uncertainty of Science, Shared Control, Critical Voice and Student Negotiation) are evident. It is somewhat different from other learning environment instruments such as the *Test of Science Related Attitudes* (TOSRA). The TOSRA is a questionnaire that has elicited attitude to science and scientists as well as attitude to science process and

experiments. Whereas the CLES questionnaire maintains a greater focus on constructivist practices in the classroom. For example in the CLES there are two scales describing the nature of relevance in science activities titled Personal Relevance and the process of co-construction of learning titled Shared Control. Both these particular scales have dimensions of the concepts perception and attitude described earlier. Both terms have a common ground in many of the items that are associated with these scales.

2.8 CHAPTER SUMMARY

This chapter has described how the New Zealand science curriculum has undergone major changes over the last century. Currently, schools and teachers are also in the midst of change with respect to how science is taught rather than just the focus on science content.

Collaborative learning has been shown in the literature to have been well documented over the years. There have been significant contributions from researchers in revealing effective teacher practices with regard to collaborative learning environments and how these relate to the learning theories that exist.

Learning environment research has a long history including many different quantitative instruments and qualitative methods to determine student perceptions and their attitudes to their learning. The scales of the CLES are well tested around the world to further explore student perceptions of their science learning.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This research method used a quantitative instrument, the *Constructivist Learning Environment Survey* (CLES) and a comprehensive range of qualitative voice to address the research questions of the study. This chapter explains the methodology in how both the quantitative and qualitative data were collected. Section 3.2 describes the nature of the teacher professional development programme that was conducted through the study and the rationale to the questions and objectives is presented in section 3.3.

There was an action research approach to the overall program design and the nature of this was initially to gain further understanding of students' perceptions of their immediate learning environment in science lessons and secondly to invite discussion and reflection with teachers from the data gathered. Professional development in the form of one-day workshops with the teachers of the classes was carried out. Data gathered in this study guided the professional development programme. There was also online communication usually via emails and some postage of material throughout the three-year project for the teachers.

The CLES scales examined the immediate learning environment in a quantitative manner but they also helped shape the qualitative aspect of the project, particularly the choice of learning themes at the professional development workshops. Furthermore, the scales of the CLES helped keep the research manageable and valid. They clearly defined the CLES and in addition formed a structure for the student interview questions. The students' drawings added another rich qualitative insight into the lives of students at each school. Further description of the selection of the

quantitative instrument and the purpose of the qualitative data are looked at in Sections 3.4 and 3.5, respectively.

Overall, the research was primarily concerned with student views of learning in their science lessons which included the following data collection:

- the CLES- measuring actual, preferred and post actual student forms;
- audio-taped recordings of semi-structured interviews (These interviews had set questions designed to link with the CLES scales but they also had a degree of opportunity for students to discuss other ideas if they so wished) for groups of students that explored student perceptions and attitudes to science learning;
- recordings of interviews with teachers related to teaching and learning;
- learning drawings produced by students exploring learners' views of science lessons; and

Sections 3.6 and 3.7 describe the school selection and demographics respectively. All the secondary schools in the Bay of Plenty and the Waikato regions of the central North Island of New Zealand were contacted and invited to take part in the study titled *Please Let Us Take Off* (PLUTO). The project was advertised as a three-year professional development package with the research aligned with the professional learning.

Table 3.1

The PLUTO Project Numbers of Schools and Teachers

Year	Number of schools	Number of teachers
2009	13	13
2010	12	16
2011	8	12

Throughout the three year study there was a core group of teachers and associated schools that remained committed to the project; this group consistently attended the

workshops and participated in the research. The teachers who had left the project due to personal reasons or changes to their classes, still remained in active contact via online communication. In the years 2009 and 2010, all the classes were surveyed with the CLES using the actual and preferred forms early in the school year and again later in the same year using the (post) actual form. All students of the classes were given a voluntary opportunity to be part of the research. Further description of the ethical considerations is given in Section 3.9. The data sorting and analysis are described in Section 3.10.

Fraser and Fisher (1986) proposed a straight forward strategy for changing the classroom environment, by which teachers can use information attained from the quantitative instruments such as the CLES to guide attempts to improve their classroom environment. This tactical approach seemed suited to the type of situation and context of secondary school science learning and teaching in this project. Other researchers have used this strategy with a variety of instruments (Fisher & Fraser, 1991; Fraser, Docker, & Fisher, 1988). The steps for changing the classroom environment in summary are as follows (Fraser & Fisher, 1986):

1. Assess student - actual and student - preferred perceptions of the classroom environment.
2. Draw profiles of student – actual and student preferred perceptions.
3. Reflect upon the profiles. Contemplate intervention strategies.
4. Intervene to change the classroom environment.
5. Reassess student – actual perceptions.

These steps were used to plan the professional learning sessions with the teachers in the project and maintain a consistent process to the methodology.

3.2 TEACHER PROFESSIONAL LEARNING

As mentioned earlier, the teacher professional development was predominantly face-to-face one day workshops, however email communication was also going on between the teachers and a website used to upload resource material that was shared amongst

the teachers. The science teachers of the classes were requested to attend four workshop days through the year, over the three years. The workshops were held towards the end of each school term and there was also an initial workshop in February to meet and prepare for the year. The teacher professional development was based on the Fraser and Fisher model explained in section 3.1. Two main objectives of the professional development were significant in this study. The first of these was that the nature of the workshops was not a top-down model where the researcher was seen to be a facilitator with all the right answers and best teaching strategies to solve problems in science lessons. Professional development over some recent years in New Zealand has sometimes been understood as the more traditional approach to in-service where teachers often experience requests to implement the new curriculum or initiative. This professional development was purposely built around the teacher inquiries linking their students' data and their particular inquiries were seen as professional puzzles to be examined closely over the school year. The CLES data and qualitative voice were the evidence used to construct a picture of the actual and preferred learning environments and hence changes to the learning environment would be evidence-informed. All the scales of the CLES were examined carefully in the workshops, their descriptions explained and their implications for teacher practice in science lessons. Secondly, the professional development offered an opportunity for the teachers to talk openly about their practice and take the chance to be with a group of teachers that could experiment with new or different teaching practices but with the importance of having evidence to inform their conversations. This forum of professional development also provided the opportunity to examine different views of learning in science classrooms.

The researcher selected appropriate academic literature such as sections of the Watkins, Carnell and Lodge text- "Effective Learning in Classrooms" and also the text by John Loughnan "Enhancing professional knowledge for classroom practice" to support the teacher inquiries and maintain vigour in the discussions around effective practice. The researcher constructed the design of the professional development in a way that it would be accessible and engaging for the teachers so that it offered possibilities for bridging the theory-practice gap. This particular tension is explained more fully in the literature section 2.4.3 on challenges in teacher professional learning.

In the workshops, a large amount of time was allocated for the teachers to discuss their students and what was happening in their science lessons. The learning drawings were popular pieces of data that teachers brought along to discuss and reflect on. Sometimes the CLES data and its definite scales of student perception could be overlooked in the teacher discussions as the year went on. However, the scales of the CLES maintained a focus for the overall professional development.

The teachers' backgrounds and experience were wide ranging. Most of the teachers were experienced with many in the group having 10 to 20 plus years of practice in the secondary science classroom with nine teachers having responsibility in the science department as the role of HOD science. However, there were two teachers in their second and third year, respectively, and their contributions to the workshops were valuable in that they had recently graduated with science degrees and pre-service teacher training. Two teachers were NZ Māori and they contributed awareness to cultural responsiveness in their classrooms in the professional development discussions. They spoke candidly about the importance of Māori protocols in the classroom and how they were treated as Māori in their own childhood education.

One of the teachers had an extensive background in sports and outdoor activities, being a keen sportsman he spoke of using physical education contexts in his science lessons. It was in the CLES findings of his particular students that it was noticed they perceived higher perceptions of personal relevance. His male students also spoke positively about how they saw him as a role model and how they engaged with the activities that were connected with sporting and outdoor pursuits. It was interesting to note how the students' perceptions can be affected from the teachers' backgrounds and interests. This was observed in a number of classes and section 5.2 describes some further qualitative details with regard to student perceptions and the links with their teacher's backgrounds.

Some important aspects of this study were that the teachers had been invited to the study and they were aware that at any time they could opt out of the study. The research data would be processed for them throughout the year and the researcher could be contacted at any time for support. This part of the study was not intended to be a form of compulsory professional development where an inflexible programme

would be rolled out for the teachers. The professional learning was constructed *with* them rather than *for* them. And the teachers saw this as an opportunity to inquire deeper into their own practice and explore different practices that they would be able to take back and use in the classrooms.

3.3 RESEARCH QUESTIONS AND OBJECTIVES

This section presents the two research questions and the three objectives. It explains the rationale behind the choice.

3.3.1 Question one

What are the students' attitudes and perceptions of their experiences in year 9 and 10 science?

This question posed the motivation to find out more about the immediate viewpoint of students in junior secondary science classrooms. It challenged the necessity to examine the present learning environment and gather a benchmark of information to inform the project. There have been significant changes to the content of the 2007 New Zealand curriculum with regard to 21st century competences and the *Nature of Science* strand. All the same, has this influenced the students' position on their view of science learning? Many of the research findings over the last 30 years in New Zealand point to constructivist approaches being used when effective teaching and learning take place (Bell, 2005). Has this well-founded research made an impact on recent teaching practices and hence on students' attitudes and perceptions in science classrooms now?

The CLES was an ideal instrument to help answer this question for a number of reasons: the CLES focuses on the science learning environment; it also has both actual and preferred forms and it is an efficient survey, quick to administer to a reasonably large sample of students from different schools. The significance of having two forms of the instrument highlighted the need to take the opportunity to compare the actual and preferred situations, so comparisons can be made regarding the effect of what

actually was happening in the immediate environment and the student's ideal perception of the learning environment.

3.3.2 Question two

How could the learning environment be changed to improve students' attitudes and perceptions?

Once data had been collated, a phase of evaluation and reflection took place interpreting the results. These data were used as a vehicle to generate feedback information from the student responses to the questionnaires. Profiles were constructed from the initial data, particularly the classes mean scores were very valuable in thinking about the next steps of intervention - this was in terms of constructivist practices in the classrooms. It was the differences between the actual and the preferred learning environments that were used to consider how the learning environment could be changed. These particular aspects of the CLES and the combination of the qualitative voice that was collected had a powerful effect on creating the opportunity to discuss optimal learning conditions. Knowledge of the preferred learning environment findings from each class and in particular the racial differences, for example Māori and European, and gender differences, which linked to the preferential learning environment, effectively challenged the PLUTO group of teachers to realize there was opportunity to make a change.

Improvement plans were developed at the teacher professional development workshops with reference to the models of learning e.g. Reception, Construction and Co-construction, outlined in Section 2.7. The scales of the CLES targeted the five constructivist ideas, namely, Personal Relevance, Uncertainty, Critical Voice, Shared Control, and Student Negotiation. These further focused and fine tuned the on-going teacher professional learning. The CLES scales and the CLES instrument are discussed in more detail in Section 3.3.

The four objectives of the study are outlined in the following sections. They shaped the purpose of the research and provided targets for the PLUTO project.

3.3.3 Objective one

To provide validation data for the use of the CLES in New Zealand secondary schools and use qualitative student voice to further inform the project.

It was important that this study had validity and that it measured what it set out to measure. The purpose was to gather and assemble both quantitative and qualitative data in a systematic way.

To provide valid data a range of different secondary schools from the central North Island of New Zealand was invited to join the PLUTO project in the year 2008. This wide selection of students from different schools would be a satisfactory data source to inform the study. Generally there was a minimum of one junior science class participating in the research from each of the 12 secondary schools. The classes chosen were mixed ability and it was expected the teacher of that class would remain with them for the entire year. However, some classes did have their teacher for two years.

The quantitative measure used in this study was the CLES questionnaire and actual and preferred forms of the CLES were administered to each of the participating classes, first initially by the month of April and then secondly the CLES actual questionnaire was administered to the same classes at the end of the year, in the month of November. For both years 2009 and 2010, all students in the classes of the PLUTO project were invited to complete the CLES questionnaires and the method of administering and collating the CLES did not change. There was no use of the CLES in the year 2011 because there was ample data collected in the previous two years. The CLES questionnaire instructions and the corresponding items in the CLES questionnaire did not change throughout the study. The purpose of this particular method of administration of the CLES was to measure initial students' perceptions of the learning environments and also to see if any shifts had occurred in student perceptions that had taken place over the year.

The qualitative measure used in this study was the use of student interviews which were completed at the end of each year in 2009, 2010 and in 2011. Taped audio

recordings took place in the student interviews so that the audio data could be interpreted by the researcher and also played back to teachers in professional development sessions. Also in the years 2010 and 2011 student learning drawings were collected to support further student voice to help triangulate with the CLES data. The student interviews questions were based around the CLES scales and the student learning drawings were also interpreted around the CLES scales for consistency. The CLES scales were used as consistent themes in the nature of the qualitative measure.

The analysis of both the CLES findings was interpreted by the researcher using ANOVA and Fathom statistical applications of the raw CLES data. The University of Curtin provided ANOVA statistical analysis with particular attention to statistical significance of the individual CLES scales and with respect to differences in CLES data in terms of gender and ethnicity. Further analysis was performed with Fathom software used to determine relative percentage of students in response to specific items of the CLES.

For the research questions to have informed responses, the study required a reasonably sized sample of students from a cross section of New Zealand secondary schools. Consequently, there were approximately 12 schools that took part from a large region of the central North Island. This included more than 400 students in each year of the study, over three years. All students were aware that they were being studied as a class and their participation in any of the CLES questionnaires, student interviews and learning drawings was entirely voluntary and that they could opt out at any time. Written permission was sought from both the students and their parents/guardians.

It was important that the project gathered the data in a reliable and efficient manner. According to Fraser (1989), teachers prefer an assessment method that is more economical in terms of speed of administration and scoring. The CLES instrument had clearly identified five key scales of constructivist learning and this showed lucidity in what it wished to measure. It has been well used in studies in science and mathematics, and validated in many countries. However, only a surprisingly small amount of research in New Zealand has used the CLES. As a result this research aimed to gather additional and up-to-date data using the CLES.

3.3.4 Objective two

To determine the effect of a collaborative approach to learning on the attitudes and perceptions of students with teachers in this project.

There is awareness by schools and academics that teachers in classrooms are using collaborative classroom strategies. Lowe (2004) provides evidence of some promising moves towards more cooperative student-to-student interaction in New Zealand schools. There also has been a focus by some New Zealand schools for course design to be co-constructed by teachers with students (Cowie et al., 2011). In addition there is an abundant supply of educational resource books, where collaborative and cooperative inquiry strategies are well described for teachers to implement. However, what effect has this had on the students' perceptions and attitudes in science? The use of the CLES and the qualitative voice supported the teachers to be informed about how collaborative approaches can affect students' perceptions of science. This helped identify what strategies worked well in classes.

3.2.5 Objective three

To determine what can be done differently to improve the learning environment in secondary science classrooms in New Zealand schools and explore models of collaborative learning, on how changes could be made.

Although there has been considerable research data collected on the perceptions of students' learning in science classes, particularly the early work in the *Learning in Science* project in the 1980s in New Zealand (Osborne, 1985) and the highly acclaimed work by Fisher and Fraser in the 1990s in Australia, not much has been done to support teachers in New Zealand to assess their learning environment and improve on it. A basic procedure was set up to ensure this project targeted improvement of the learning environment not just measurement of it. As outlined earlier in the introduction (Fraser, 1989) five steps were put in place with the assessment and improvement of classroom environment in mind. They are: 1. Assessment; 2. Feedback; 3. Reflection; 4. Intervention; and 5. Reassessment.

3.3.6 Objective four

To examine the implementation and delivery of the New Zealand curriculum (2007), with particular reference to the key competencies and the Nature of Science strand and how this could affect changes to the learning environment.

All the students involved in this research project attended secondary schools that abide by the statutory requirements of the 2007 curriculum. These legal requirements for schools' boards of trustees and associated teachers are laid down by key considerations outlined on page 37 of the New Zealand curriculum. They are the vision, principles, values and the five key competencies. Schools and teachers are expected by the New Zealand Ministry of Education to have designed their learning programs for their students with these in place. The key competencies are described as the "Capabilities for living and lifelong living" (Ministry of Education, 2007, p. 12) and are perceived as significant to learning in every learning area. The key competencies are not usually assessed as such, but they are expected to be evident where learning programs are designed to embrace them. The following five key competencies are described as in the curriculum document:

- Thinking - is about using creative, critical and meta-cognitive processes to make sense of information, experiences, and ideas.
- Using language, symbols and texts - is about working with and making meaning of the codes in which knowledge is expressed.
- Managing self - is associated with self-motivation, a "can do" attitude, and with students seeing themselves as capable learners.
- Relating to others - is about interacting effectively with a diverse range of people in a variety of contexts.
- Participating and contributing - is about being actively involved in communities. Communities include family, whānau, and school.

The *Nature of Science* strand is found in the science learning areas on pages 45 to 52 of the NZ curriculum. It is the overriding and unifying strand that underpins the content knowledge of science described in the document. Similar to the key

competencies, the strand describes the overall philosophy: Understanding science; Investigating in science; Communicating in science; Participating and contributing.

Both the *Key Competencies* and the *Nature of Science* fittingly linked with the constructivist approaches to this project. The CLES instrument seemed a very appropriate tool to be used and made sense of the students' perceptions and attitudes with these competencies and nature of science strand at the focus. One good example of this was the description of the *Nature of Science* strand "They (students) come to appreciate that while scientific knowledge is durable, it is constantly re-evaluated in the light of new evidence, and they (students) come to see science as a socially valuable knowledge system" (Ministry of Education, 2007, p. 28). The essence to this explanation related directly with the Uncertainty scale in the CLES. This was defined as: students have opportunities to experience that science has changed over time; that science is evolving, and is culturally and socially determined.

The researcher placed emphasis on the process of his reflection and evaluation of the CLES findings coupled with the implementation of the *Key Competencies* and the *Nature of Science* strand in the classrooms studied. This is further described in Chapter Five.

3.4 SELECTION OF THE LEARNING ENVIRONMENT INSTRUMENT: THE CLES

There is a wide range of quantitative learning environment instruments that have been successfully used throughout the world in learning environment research. However, this particular research required an instrument to measure the learning environment as perceived by students in the context of science classrooms in New Zealand. All the classes in this research were from English medium secondary schools, so no translation into Te Reo Māori was necessary. The quantitative instrument requirements for this research were:

- concise with carefully selected scales that focused on socio-constructivist ideas;

- a survey that was short enough so that 13-14 year old students could quickly respond to the questions and not be onerous for them;
- having both actual/preferred forms. The actual form would measure the immediate learning environment. The preferred form would be concerned with goals and value orientations; this would measure the students' perceptions of the science classroom ideally liked;
- a survey which used appropriate language that 13-14 year old students could understand and relate to.

It was important the students did not have to spend a lengthy period of time answering the script. The researcher was conscious that the students would have to repeat the survey later in the year, and with some classes, again in the following years. The teachers involved were requested to give up some of their teaching time to administer the scripts, so the survey had to be efficiently, but at the same time effectively, done in science time. The CLES seemed ideal and furthermore, had been validated in many countries. Comparisons could be made with other research coupled with the data coming in from each year in New Zealand. Most importantly, the researcher required an instrument that teachers could pick up and quickly recognize that the socio-constructivist dimensions of the classroom were being examined.

The administration of the CLES actual and preferred forms was initiated in March of 2009 and the post actual CLES in November of the year 2009 with 327 students participating in the CLES survey including 185 female and 142 Male students in 13 schools.

The CLES was repeated again, both actual and preferred forms in March of 2010, the post actual CLES in November/December of 2010 with 362 students participating in the CLES survey including 223 female and 139 male students in 12 schools.

The actual form of the CLES survey had a blue highlighted heading on the script and the preferred form had a red highlighted heading, so confusion was minimized. Teachers were sent the scripts in the post about a week before the time of administration and also in the enclosed bag were written instructions for the teachers

on how to administer the scripts. There was a teacher professional learning workshop at the beginning of each school year on the 16/17th February 2009 and on the 15/16th February in 2010. In one of the sessions at these workshops, the researcher explained the administration method of the survey and the ethical considerations of the research. Teachers in the project would then have a consistent method of administration of the scripts. The significance of time of the day and the sequence of administering the scripts was also explained to the teachers.

There was no student identification on the scripts, due to ethical considerations of individual student recognition. Therefore, a method was constructed to give an opportunity for students to have their own secret number and a group number (If they were working in groups). A student was then able to decide on a number and write the number on the script, where there was a box labelled: *My Secret Number*. Some groups had group names rather than numbers, so some scripts ended up with names of groups written down. The sole purpose of the secret number was that the researcher could marry up the actual data, the preferred data and the post actual for each student for the year. This was particularly important when professional discussion with the teachers concentrated on preferred and actual environments per student and groups of students. The researcher could also evaluate groups of students working together in the class and evaluate overall trends over the entire cohort. Students were requested to remember their secret number over the course of the year verbally by the teacher and in writing on the instructions when the CLES was administered.

The ethnicity of the student was labelled: *NZ/NZ Māori/Pasifika/Other* in a box, with students requested to circle one of the options.

The gender of the student was labelled: *Male/Female,* with students requested to circle one or the other. The students were given 50 minutes to one hour (one period in duration) to complete the questionnaire. The actual form was requested to be completed first then the preferred form later in the week. It is important to note that the students had been with their teacher for a good portion of the first term so class routines were in place and also the students had had time to get to know their teacher and their classmates. The actual and preferred forms were usually administered by

the earliest time in March to towards the end of April hence the students would have attended approximately 7-9 weeks of contact time with their teacher.

There was a box on the script at the end of the 25 items labelled: *If you wish you can add any comments about your learning here.* This was an opportunity for students to write a response if they wanted to in this space. This was done for both the actual and preferred forms.

There was no change to the overall content, items, headings, and scale or student instructions of the CLES itself. *Taylor & Fraser, Curtin University, March 1998 version* was labelled at the bottom right of every page printed.

Table 3.2

The Descriptions of the CLES Scales

Scale Name	Description	Sample Item (Actual form)
Personal Relevance	Learning about the world	I learn about the world outside of school
Uncertainty	Learning about science	I learn that science has changed over time
Critical Voice	Learning to speak out	It's Ok for me to express my opinion
Shared Control	Learning to learn	I help the teacher to plan what I's going to learn
Student Negotiation	Learning to communicate	I get the chance to talk to other students

3.5. QUALITATIVE VOICE

A range of methods of collecting qualitative data was used and in this section they are described. The purpose of collecting the qualitative data was to triangulate with the CLES data and provide further interpretation of student perceptions of their learning in science lessons.

3.5.1 Audio recorded student interviews

Student interviews using a digital audio recorder took place toward the end of the year of each year, usually in mid to late November. Six selected classes out of the 12 schools were interviewed in each of the years. The reduced number of classes were selected to help keep the research data manageable and to take a qualitative "snapshot" rather than interview all participating classes. There were a total of 67 recorded interviews that took place and there were approximately 4-5 groups of students from each of the six classes that were interviewed.

All students had the option of withdrawing from the interviews and it was made clear that it was purely voluntary. The students and their parents/guardians were informed about the interview time and the set of interview questions (Table 3.3) were supplied two to three days before, so that the students were made to feel as comfortable as possible about the questions and have time to reflect on some of the points. The interview time for each pair of students was approximately 5 to 10 minutes and it was expected that the students would be able to answer the questions freely. The interview time interval was taken from their science lesson time only so there was no disruption to their other subjects. Students' confidentiality was maintained throughout the course of the interviews, and numbers and pseudonyms have been used to maintain anonymity. The researcher conducted the interviews, while the teacher of the class organized the students in an order for interviewing purposes. All participants in the interviews were encouraged, but not forced, to contribute to the questions.

Students were in pairs or threes when the interviews took place. The reasons for this were that it was very likely the same students worked together in these particular groups in their classes. The researcher was keen to hear their collaborative reflections of learning as they worked together. The interview process could have been a daunting experience for some students, so the researcher was aware that having small groups of students interviewed together would encourage students to feel as comfortable as possible. The interaction of two and three students in the interview room also gave insights into how they worked together in a practical sense in

experiments and helped with ideas being sparked by others to keep the conversations going in the interview process.

The interview room was usually a quiet space, sometimes adjoining the laboratory where the students attended their science class. Sometimes it was in the administration area of the school, sometimes this was quieter. Occasionally, the interview room was in the science classroom when the rest of the class was in the school library.

In addition to written consent, the students were always asked if they were comfortable about being interviewed at the start of the interview and whether they were aware that at any time they could withdraw from the interview.

A set of basic interview questions was established (see Table 3.3). The questions were written out on a whiteboard in the interview room, so the students could see to what they were being asked to respond. There were some more open-ended questions, which could be asked of students who seemed keen to expand on the previous questions. The prompts and additional prompting questions of a similar theme were used to ensure questions were fully answered. Students were given plenty of opportunity to comment on any issues arising from the research, this included any recommendations from a student perspective seen as important or indeed any ideas seen as worth pursuing.

Table 3.3

Questions for Audio Interviews with Students

Scale	Description
Personal Relevance	How relevant do you see the learning that goes on in your science class to your everyday out-of-school experiences? Prompting questions: What are some interesting things that you enjoy learning about which are about the world outside of school? How do you learn about these things while you are at school?
Shared Control	Are there opportunities in your lessons that you and your classmates help the teacher plan the learning and decide on activities? Prompting questions: What help do you give the teacher to help you learn? What things have you contributed to help the teacher know what to teach you?
Science Learning	How do you think science has changed over time? Prompt question: Tell me what you think how science is now compared to science long ago?
Critical Voice	How comfortable are you with expressing your opinions in class? Prompt: Is it ok for you to question ideas that are being taught?
Student Negotiation	Tell me about the opportunities you get in explaining your ideas in a science lesson? Prompting questions: Do you get a chance to talk to others in your group? Could you explain how you talk to other students about science ideas? When you are doing a problem solving activity or practical task, what are some things you talk about with your classmates?

3.5.2 Audio recorded teacher interviews

Each of the participating teachers was invited to be interviewed independently and 20 out of the 21 teachers accepted to be interviewed. The teacher who declined the invitation was travelling overseas at the time of the interviews. There were 20 audio recordings that took place, with a duration of interview time between 25-56 minutes for each interview. In New Zealand, the month of November is when the senior students sit their external exams, and this releases time for teachers to be more flexible with their work. The interviews were entirely voluntary. The researcher organized the time with the teacher approximately two weeks before the interview, usually through email correspondence. Most teachers responded positively and candidly to the interview, many took the time to reflect over the years work and the project as a whole. A basic set of questions was used but they were not as structured as the student questions. The questions were based around the CLES scales in a similar manner as the student questions.

3.5.3 Teacher evaluation/reflection form

An evaluation/reflection form was sent to all the teachers at the end of each year. There was no identification of school or teacher required on the sheet so that the teacher and schools remained anonymous. There were six statements on the form and as shown in Table 3.4.

Table 3.4

Teacher Reflective Questions

Highlights of the project have been:
My reflections about the students have responded:
Challenges in the class:
Aspects of PLUTO that could be improved:
Other reflections:
How could my school help me better in the PLUTO Project?:

3.5.4 Student's views of learning as drawings

In June 2010, the researcher gathered additional qualitative evidence to further inform the research. The researcher could sense from the teacher conversations that another form of qualitative data could be beneficial to help paint a clearer picture of student perceptions of their learning. It was apparent that the research could use other forms of data that may help with further interpretation of the CLES scales. It was important for the research to maintain the focus of the CLES scales but the researcher desired greater qualitative detail with regard to the CLES scales.

The 2010 CLES actual and preferred data had been collected and evaluated early on in the school year. There were some interesting trends that emerged from the quantitative data in both years 2009 and 2010. Graphs using the data were drawn up using Fathom and Excel software. Interpretations were generated from the trends in the graphs. The data provoked a wealth of professional dialogue with the teachers involved. However, further descriptive data of student learning was required to help triangulate the quantitative data and look for comparisons.

It was the research *Regarding learning: Children's drawings of learning in the classroom* (Lodge, 2007) involving a class of six year old children that prompted this additional activity in this study. The research by Caroline Lodge is described in detail in the section 2.7.1 Student's views of learning as drawings.

Initially, four PLUTO classes of year nine students (Two classes were at a co-educational secondary school and two were at a single sex secondary school) were invited to compose drawings of their learning in a science lesson. There was no time limit given to the students to compose the drawings. The question was posed *"What does learning look like in your science class?"* They were told they could write words in speech bubbles or directly onto the drawings if they wished. A pack of A4 sheets of white paper for the purpose of drawing on and teacher instructions were sent or given to each teacher. All students were told this was entirely voluntary and no student identification or personal information such as ethnicity or gender was required on the drawings. The teachers were asked if they would be comfortable for

the students to compose the drawings in a science lesson and were told this was entirely voluntary.

The learning drawings were completed by August 2010 and they brought further insight into the students' world of science learning. There was much teacher discussion generated from the drawings and this strategy of incorporating the learning drawings into the research seemed fruitful. This same method was repeated in the year 2011 and here all the classes in the research were invited to compose drawings of learning. Both teachers and students were told this was voluntary. The drawings were completed in the months of August and September, 2011. Not all students completed the learning drawings in each class and not all classes participated, however there was a total of 117 that were collected from 11 classes over the two years.

3.6 SCHOOL SELECTION

There are 43 secondary schools located in the Bay of Plenty and Waikato regions of the central North Island of New Zealand and all were invited in November 2008 to be part of the research. This was initially advertised through the annual Head of Department science professional learning day, where a significant number of leaders of science departments take part in a one day conference in Hamilton city. Emails were also sent out to schools describing the proposed research. A pamphlet titled: *The PLUTO Project* outlining the research and the overall aims of the project was sent to the interested science leaders and their principals.

Table 3.5

School Selection

School	Number of classes	Year participated
Te Puke High	1	2009-2011
Hamilton's Fraser High	2	2009-2011
Waikato Diocesan for Girls	1	2009-2010
Tauranga Girls College	1	2009-2011
Te Aroha College	1	2009-2010
Putaruru High	1	2009-2011
Cambridge High	1	2010-2011
Morrinsville College	1	2009-2011
Forest View High	1	2010-2011
Fairfield College	1	2009-2011
Tauhara College	1	2009-2010
Te Awamutu College	1	2009-2010
Mercury Bay Area	1	2009-2010
Te Kuiti High	1	2009

A total of 14 different schools volunteered and participated in the study over the three years, 2009-2011. Table 3.5 summarises the participating schools with their names, number of classes and the year in which they participated.

The goal of the study was to involve a wide range of different schools across the two geographic regions with one, sometimes two, classes of year 9 or 10 students from each school. It was important to have a portion of students from a number of schools contributing to the research so that overall trends and patterns could be evaluated across the regions rather than from a small sample of schools in one area. Science teachers from the associated schools who showed initial interest were invited to take part in the research and hence the students were also invited to take part. A letter was posted to each school confirming their place in the research and it also explained the events that would take place over the course of the research for a year. An initial workshop in mid-February of each of the years was organized to inform the teachers

about the research and so that the teachers would get to know one another professionally with a common focus. There was no monetary cost to the teachers for their involvement in the research.

The reasons behind why only 14 out of 69 schools volunteered were likely due to teacher and school professional development commitment. Not all schools receive the same funding with regard to teacher class release in New Zealand and hence the school commitment was due to how much time a teacher could be released for the professional development workshops. There was also the personal teacher commitment, which was significant over the time of the study and teachers had to weigh this up with all their other commitments and school initiatives that go on.

3.7 DEMOGRAPHICS

The Waikato and Bay of Plenty regions cover 37,000 square kilometres of mainly rural land and coastal land. The regions are geographically divided by the Kaimai ranges and situated in the central and east of the North Island of New Zealand. The Waikato and Bay of Plenty economies are strongly based on: agriculture, especially dairy farming; horticulture where kiwifruit, avocadoes and apples are grown; forestry; and tourism. Sixteen per cent of NZ's total population resides in the Waikato and the Bay of Plenty regions (The University of Waikato, 2011). There is evidence of both prosperous towns and communities in poverty throughout the regions. Some of the secondary schools in this research have students who live below the poverty line and some of these children struggle to bring lunch to school. On the other hand, one participating school, with a decile 10 rating, had students who would predominantly live with affluent parents. In each New Zealand school, there is a decile rating specified and the New Zealand Ministry of Education determines this rating value through the census statistics and enrolment data collected at the associated school. It is a measure of the school's community wealth. School communities are rated on a scale of one to ten, with one being the poorest and ten the wealthiest. In this research, the schools had a decile range from 3 to 10. Nevertheless we must be reminded that there is still a wide range of students with very different socio-economic backgrounds attending each school. In eight out of 14 schools in this research, they were the only secondary school in that particular town. Hence, the

majority of students who reside in the particular community will most likely be attending their local high school and are unlikely to travel a lengthy distance to attend another secondary school.

English is the most widely spoken language and Te Reo Māori is the most common minority language spoken by 9.6% compared with 4.1% nationally (Environment Bay of Plenty, 2011).

In the 2006 Census, 67% of the resident population identified themselves as ethnic European. 27.5% of the Bay of Plenty and 22% in the Waikato regions' populations identified themselves as Māori (Statistics New Zealand, 2006). According to local Māori traditions, the Bay of Plenty was the landing point of several migration canoes that brought Māori settlers to New Zealand. Both the Waikato and the Bay of Plenty regions have reasonable sized populations of Māori living in all the towns. Some schools do have large proportions of Māori and some of these have strong connections with their local Marae.

Of New Zealand's population 7.2% are Pacific Island people and of those, 22% live in the Bay of Plenty and Waikato regions. Pasifika is a collective term used to refer to people of Pacific heritage or ancestry who have migrated or have been born in New Zealand. They identify themselves with Samoa, Cook Islands, Tonga, Niue, Tokelau, Fiji, Solomon Islands, Tuvalu and other Pacific countries. There are a small percentage of Pasifika students who also attend schools, some of them are represented in this research.

3.8 SCHOOLS IN THIS STUDY

All the schools had a similar structure in the makeup of subjects at the junior level, with science being taught by specialist science teachers from Year 9 onwards. Students remained together in their class for their core subject such as science for the entire year. In all the schools, there were three, sometimes four, lessons of science per week, depending on the timetable structure. It was highly recommended to each school that the class that was participating should have their teacher remain with them for the entire year.

The participating schools had a roll size between 322 and 1,705 students and student ethnicity was predominantly European, with the addition of 8% to 49% Māori, 0.1% to 10% Pasifika students. A summary of the number of schools, decile rating and ethnicity is given in Table 3.6.

Nine of the schools are classed as rural and five classed as urban. Two of the schools were all girls and 12 were co-educational. One school was privately funded (decile 10) and the rest were state funded. These statistics were collected from each school. A further breakdown of student ethnicity and decile comparisons in this research will be described in Chapter 4.

Table 3.6

Participating Schools and Student Ethnicity

Number of schools with the same decile	Decile rating	% Māori	% Pasifika
3	3	13 to 40	2 to10
3	4	14 to 36	2 to 5
2	5	33 to 34	3
4	6	14 to 30	0.5 to 2
1	9	11	0.1
1	10	8	0.2

3.9 ETHICAL CONSIDERATIONS

Ethics approval for this research was sought and granted by the Human Research Ethics Committee at Curtin University.

Informed consent

Participation of the teachers was entirely voluntary and they were informed about the research methods through both written information material and verbal discussion with the researcher. They had the opportunity to withdraw from the research at any time. The parents of students involved were informed about the research by an

information sheet that was sent home. They had the opportunity to withdraw their children at any time through the period of study. This would have meant that the student would continue with their regular course work but would not be asked to complete a CLES questionnaire, or agree to be interviewed, or be asked to compose a learning drawing. Students also had the opportunity to withdraw from the research at any time. Those students were still expected to maintain regular attendance in the science classes, just as normal.

The methods in the research used to gain consent and inform all participants were made verbally and in written form to minimize any risk of misinterpretation of the information given. Written permission and consent were obtained from the parents of the students, the student themselves, the teachers and the schools involved in the study. All participants and the parents of the participants had the opportunity to discuss any additional information with the researcher or the supervisor via their email or telephone contact. This contact information was stated on the information sheet and consent form.

If some students did have problems reading or interpreting the questionnaires or questions in the interviews, there was time and opportunity for the students to clarify them with the teacher or researcher. In addition to this, it was clearly indicated that it was the students' opinion that was wanted from the research and there were no right or wrong answers. This was written on the CLES scripts and students were briefed of this in all interviews.

Cultural awareness and protocols

Discussion with the school community and the principal was initiated by the researcher before the research took place when considering Māori and Pasifika protocols. This was usually in the form of a telephone call and email correspondence which considered cultural perspectives to which the research needed to be responsive. Some schools in the research suggested certain cultural understandings were required to be anticipated, such as when the researcher was introduced to the class of students for the first time, also certain protocols were discussed when this happened. A karakia which is a Māori prayer can be recited in some classes, also a

waiata (Māori song) can be sung when the lesson starts. From this awareness, the researcher considered any subtle changes that needed to be made to the methodology and the language used; this was unique to the individual schools and classes.

The important aspects of cultural awareness for the researcher was the act of request for understanding, being proactive to understanding the customs and taking steps to further understand the school community's values in which the research was conducted. The researcher was aware of correctly pronouncing school, teacher, and student names. The researcher was also aware of the unequal status of the participants and took steps in the research method to minimize vulnerability of the participants. The following aspects of anonymity and data storage also brought attention to this.

Anonymity

Protection and privacy for all participants was maintained throughout the project. Anonymity was accorded to all participants and they were encouraged but not forced to contribute to the study. There was no identification using student names on any audio transcript, learning drawing or CLES script. Only numbers or pseudonyms were allocated to the data for organization and evaluation. The numbers were not linked to participant names. The questionnaire scripts and interview questions were not of a personal nature and were solely from a learning environment perspective. No individuals were identified in the study findings and the raw data were only available to the researcher and his supervisor.

Data storage

Questionnaire scripts, interview transcripts and learning drawings have been kept with the researcher, stored in the researcher's office in a locked cabinet and not with the classroom teachers to minimize vulnerability of the participants. The CLES data have been stored in an Excel spread sheet and the statistics informed from the research is stored in the researcher's personal computer. The computer is user name and password protected. On completion of the research all data will be stored for a period of five years at Curtin University and then destroyed.

3.10 DATA COLLECTION

In 2009, the CLES was administered and collected over two events in the year. Once in March-April with the posting out of the actual and preferred forms of the scripts of the CLES to each teacher and then a repeat of the actual form of the CLES in November. This was repeated again with the identical method in 2010. Classroom teachers followed the instructions on an information sheet enclosed in the pack of scripts before they administered the CLES scripts to their classes. They were administered in the early part of the day. Completed scripts were posted back to the researcher for collation and data input at each event. Table 3.7 summarises participation numbers with the use of the CLES.

Table 3.7

CLES Participation in Terms of School, Student Gender and Ethnicity

Year	Schools	Teachers	Students	Female	Male	NZ European	NZ Maori	Pasifika	other
2010	12	16	362	223	139	223	86	13	40
2009	13	13	327	185	142	193	100	-	34

Classes were visited in the period of research in the years 2009 to 2011and different classes were surveyed each year. General observations and running records of the observations were made of the classes with regard to how the classes were operating. There were other observation visits where the researcher visited the class and the teacher. On these occasions, further discussion of the research was carried out with the teacher but with significance to their particular class. It was important that the research had the ability to support effective teaching practice with the nature of the class and students in mind. A collection of notes was made by the researcher on these visits to keep track of events.

A collection of written notes was also made of the professional learning days that occurred four times in each of the years. The professional learning days occurred

once a school term where the researcher and the teachers met and shared their understandings.

In summary, qualitative data were collected from student and teacher interviews in November in 2009, 2010 and 2011. The learning drawings were collected in August 2010 and in August/September 2011.

3.11 DATA SORTING AND ANALYSIS

The data analysis focuses on the objectives of this study, the first part of which was to provide validation data for the use of the CLES in New Zealand. The measures used to validate the CLES were, the Cronbach alpha coefficient (Cronbach, 1951) to assess the internal consistency of the CLES scales, and the mean correlation of a scale with the other scales was used to check the discriminant validity of the scales. This was completed in the years 2009 and 2010.

Having validated the CLES, the second objective was to determine the effect of a collaborative approach to learning on the attitudes and perceptions of students to science learning. All classes had aspects of collaborative learning going on and no classes were identified as more or less collaborative as another. However, the scale means from each class were used to identify any statistically significant variations among the results. This data were triangulated with qualitative data obtained from student, teacher interviews and student learning drawings. Variations in both forms of data were then evaluated and reflected on.

The other aspect to the data analysis was to determine relationships of gender, school decile rating and ethnicity with students' attitudes and perceptions to science. The mean scores of the CLES were used to look for possible contributing factors. The data were analysed using the SPSS and Fathom software. This statistical analysis of data is described further in Chapter 4.

3.12 CHAPTER SUMMARY

This chapter began with the research questions and the rationale behind them. It has described how they and the objectives have shaped the methodology that followed and how this has fitted with the steps of changing the classroom environment that Fraser and Fisher (1986) suggest. The two questions challenged the research to measure the immediate learning environment at the junior levels of secondary schools and how improvements could have been made. The objectives have described the aim of collecting data to validate the CLES instrument, the comparison of pre/post differences and the determination of what could be done to improve the learning environment. The final objective aimed to take a closer look at the New Zealand curriculum with particular reference to the nature of science and the key competencies and how both could have affected the learning environment.

The details of the method of collection, sorting, and analysis of qualitative data are described in conjunction with the administration of the CLES instruments over the term of the research.

This chapter also presented the demographics of the schools and the details of types of schools that have volunteered to be involved in the research.

Finally, the ethical requirements are expressed in accordance with the Human Research Ethics committee and a description of cultural sensitivity to the students and schools in the research.

CHAPTER 4

PRESENTATION OF QUANTITATIVE RESULTS

4.1 INTRODUCTION

This chapter presents the quantitative data collected in the form of summarized tables, figures and a general analysis of the results in each section. The collected quantitative CLES data were processed using ANOVA and Fathom statistical software. Both the 2009 and 2010 CLES data were recorded into Microsoft Excel files initially and then an analysis was performed accordingly. Explanations of the results in the tables and figures are provided in each of the relevant sections. The main intent of the presented data was to respond to the research questions.

The second section looks at the validity and reliability of the CLES in a New Zealand setting. In keeping with past traditions in learning environment research, standard statistical research techniques were used to measure the discriminant validity and reliability of each of the five CLES scales. The internal consistency reliability was calculated using Cronbach alpha coefficient and the mean correlation of a scale with the other four scales was used as a measure of discriminant validity.

Section 3 reports on the overall means and standard deviations for the years 2009 and 2010. The variations of the CLES mean results are presented in both tables and figures. Particular attention is drawn to the general trends in the mean values of each scale and a brief description is provided of some of the intervention strategies that took place to encourage change in the learning environments using the mean values of each of the scales. The actual, preferred and post actual results are illustrated in figures to depict comparisons between these measures. There is also an additional description that reveals differences in the CLES between the years 2009 and 2010.

Section 4 presents actual and preferred differences in the CLES data and pays attention in revealing the significance of the difference between students' actual and

preferred perceptions of the learning environment. Paired sample t-tests were calculated on the differences to determine whether the differences were statistically significant.

Section 5 presents actual and post actual differences in the CLES data and pays attention to revealing the significance of the differences between students' actual and post actual perceptions of the learning environment. Again, paired sample statistical t-values were calculated to determine the significance of the differences.

Section 6 presents gender differences in the CLES data and looks at the differences in perceptions of both male and female students. Paired sample statistical t-values were again calculated.

The final section looks at ethnic differences in the CLES data in a similar way and examines the differences in perceptions of NZ European, NZ Māori, Pasifika and other students.

4.2 VALIDITY AND RELIABILITY OF CLES

The discriminant validity and internal consistency reliability of psychological measurement questionnaires need to be established in the setting where they are used before any additional results can be considered reliable and valid. The new CLES has been used in studies of secondary schools and validated and used in various studies in different countries (Churach & Fisher, 1999). The CLES has been translated and tailored to suit each unique situation for use in both English and non-English speaking countries. The analysis of the CLES carried out by Kim, Fisher, and Fraser (1999) and the 25-item Korean version by Lee and Fraser (2000) revealed that it was consistently valid and reliable. In addition to this, a study of tertiary computer classrooms in Thailand by Wanpen and Fisher (2006) has established it as a reliable instrument for current research of learning in computer classrooms. The data gathered from the 366 student in Thailand was of a similar size to this study and the following Cronbach alpha coefficients show consistent patterns of reliability. With the individual student as the unit of analysis, the alpha reliability in the Thai study ranged from 0.76 to 0.91 for the actual form and from 0.82 to 0.93 for the preferred

form. These values imply that all the scales of the CLES possess satisfactory internal consistency in both the actual and preferred forms. The Cronbach alpha reliability values of this study which are presented later in this section show close association to the Thai study. This suggests that the CLES is a reliable and valid quantitative instrument used to research learning environments in current New Zealand science classrooms.

The discriminant validity of the CLES used in this study was measured using each scale's mean correlation with the other scales and this was taken from the CLES administered in the year 2010. Table 4.1 reports three statistics, namely the actual, preferred and post actual forms of the mean correlations; it also shows that there are five items to each scale of the CLES used in this study. The mean correlations ranged from 0.23 to 0.49 as the unit of analysis. This range indicates that the instrument has acceptable discriminant validity and each scale measures generally distinct although to some extent overlapping aspects of the constructivist learning environment.

Table 4.1

Discriminant Validity (Mean Correlation with other Scales) for the Actual, Preferred and Post Actual Forms of the CLES 2010

Scale	Number of Items	Mean Correlations		
		Actual	Preferred	Post Actual
Personal Relevance	5	0.38	0.39	0.49
Uncertainty	5	0.36	0.32	0.41
Critical Voice	5	0.23	0.27	0.40
Shared Control	5	0.31	0.37	0.47
Student Negotiation	5	0.36	0.39	0.42

N=362

The perceptions for science learning were analysed for internal consistency reliability (Cronbach alpha coefficient) and the results presented in Table 4.2 demonstrate the reliability measures for each of the CLES scales appear to be very good. With the student as the unit of analysis, the alpha reliabilities ranged from 0.74 to 0.88 for the actual form and from 0.80 to 0.89 for the preferred form for the year 2009. In the year 2010, the alpha reliabilities ranged from 0.80 to 0.85 for the actual form and from 0.81 to 0.89 for the preferred form. This suggests that all scales of the CLES possess satisfactory internal consistency in both actual and preferred forms for both years of this study.

Table 4.2

Internal Consistency Reliability (Cronbach Alpha Coefficient) for the CLES Data

Scale	Cronbach's Alpha Coefficients			
	2009		2010	
	Actual	Preferred	Actual	Preferred
Personal Relevance	0.77	0.80	0.80	0.85
Uncertainty	0.77	0.80	0.80	0.81
Critical Voice	0.74	0.85	0.83	0.86
Shared Control	0.88	0.89	0.88	0.88
Student Negotiation	0.85	0.87	0.85	0.89

N=327(2009)

N=362(2010)

Overall, the CLES can be considered to be reliable and valid for application in this study.

4.3 MEANS AND STANDARD DEVIATIONS FOR 2009 AND 2010

Tables 4.3 and 4.4 report the means and standard deviations of the actual, preferred and post actual forms in the years 2009 and 2010, respectively. The results convey significantly low values in the Shared Control actual scale for both years; however, it was interesting to see that the students' post actual perception of Shared Control had increased at the end of each year. The students were encouraged to work in small collaborative groups and there was an emphasis placed on co-constructing activities within these groups as part of improving the Shared Control aspect. The low mean actual value of the Shared Control scale of 2.23 in the year 2009 shown in Table 4.3 is also repeated with a similar low mean actual value of 2.19 in the year 2010 shown in Table 4.4. These low mean values were of contrast for the higher mean values to the Scale of Student Negotiation with mean values of 3.44 and 3.47 for the years 2009 and 2010, respectively.

Table 4.3

Means and Standard Deviations for the 2009 CLES Data

Scale	Mean value			Standard deviation		
	Actual	Preferred	Post Actual	Actual	Preferred	Post Actual
Personal Relevance	3.11	3.25	3.37	0.75	0.77	0.85
Uncertainty	3.30	3.25	3.33	0.77	0.81	0.80
Critical Voice	3.20	3.47	3.48	0.90	1.01	0.94
Shared Control	2.23	3.08	2.49	0.96	1.01	0.98
Student Negotiation	3.44	3.74	3.56	0.93	0.95	0.88

N=327

In most of the scales, the standard deviations hovered between 0.75 and 1.01, this represented a reasonable spread of student perceptions at each mean value. The

smallest standard deviation value was 0.75 for actual Personal Relevance in the year 2009 and the largest standard deviation was 1.02 for post actual Critical Voice in the year 2010.

Table 4.4

Means and Standard Deviations for the 2010 CLES Data

Scale	Mean value			Standard deviation		
	Actual	Preferred	Post Actual	Actual	Preferred	Post Actual
Personal Relevance	3.15	3.23	3.38	0.79	0.84	0.78
Uncertainty	3.11	3.25	3.23	0.84	0.83	0.82
Critical Voice	3.41	3.58	3.35	0.98	1.02	1.03
Shared Control	2.19	3.09	2.30	0.90	1.00	0.95
Student Negotiation	3.47	3.59	3.43	0.91	1.00	0.95

N=362

Students were also encouraged to speak up in all the classes and actively present their scientific findings to other class members over the course of the topic. The teacher professional development considered the interaction between both; teacher and student; student and student. In the year 2009 and 2010 professional development had emphasis to support socio-constructivist learning in the science classroom with particular attention to co-constructing the learning with the students. The scale of Personal Relevance was also identified by the researcher as a particularly significant area where the students were encouraged to learn about highly relevant topics that were presented by the media or topics were linked to their everyday experiences and contexts outside of school.

The teachers examined the mean values of all the scales closely, however each teacher had her/his particular class mean results and comparisons were discussed with respect to the overall mean values from all the classes. There was also particular attention given to the Student Negotiation and Personal Relevance scales as these scales indicated significant differences between ethnicity and gender. These differences are discussed in the later sections of this chapter.

Figure 4.1 helps illustrate the mean differences using line graphs of actual, preferred and post actual means in the year 2009. The figure exhibits the variations of the mean values in each of the scales. The figure highlights particular attention to the repetition of the low mean score of Shared Control in the year 2009 and again in the year 2010 as shown in Figure 4.2.

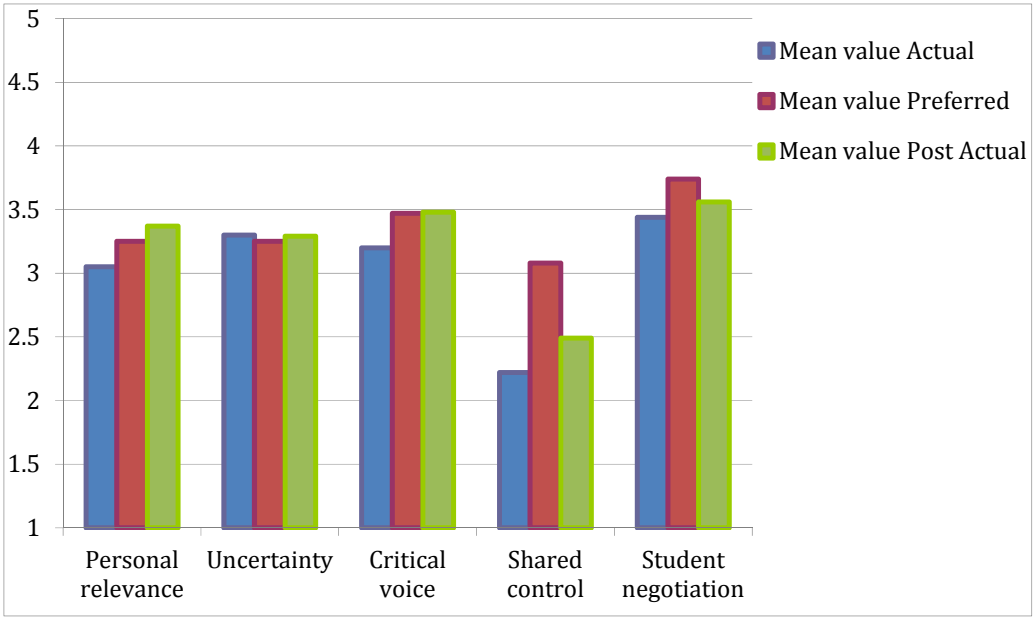

Figure 4.1. Student perceptions of actual, preferred and post actual learning environments using the CLES 2009 data. N=327.

Figure 4.2 illustrates the results of the CLES actual, preferred means across the five scales in the early part of the year 2010. It also presents the results of the reassessment at the end of that year noting the post actual mean values.

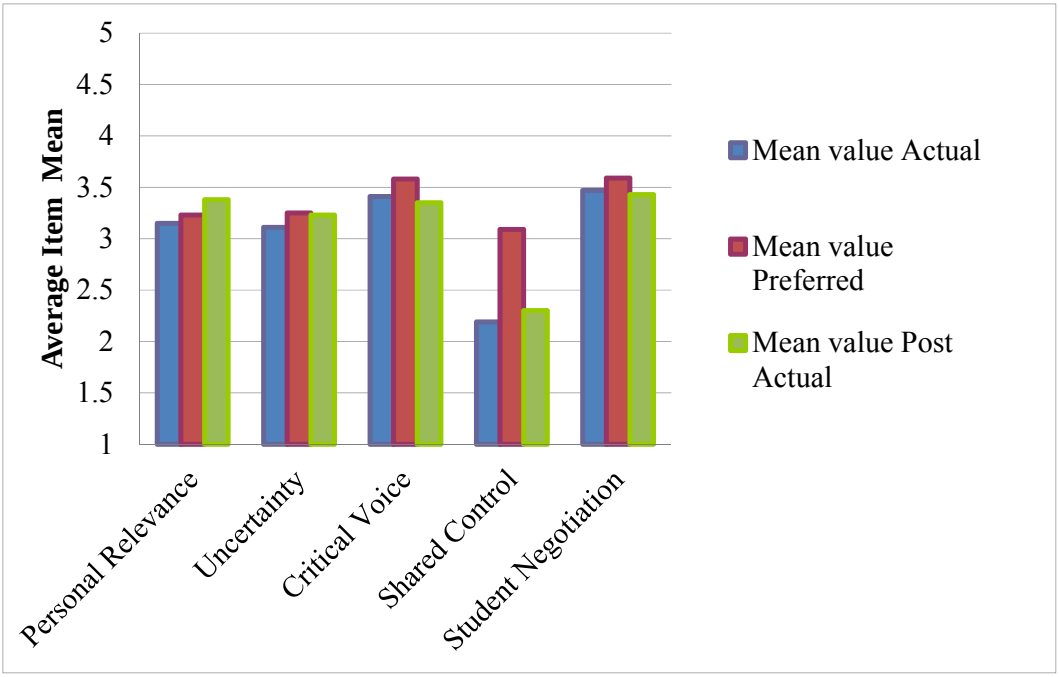

Figure 4.2. Student perceptions of actual, preferred and post actual learning environments using the CLES 2010 data. N=362.

From both the years 2009 and 2010 Figures 4.1 and 4.2 show evidence that the students' actual perception of shared control is much lower than the other scales. Their preference of shared control in both years remains considerably higher than the actual mean values. Further interpretation of the mean values of the particular scales is discussed later in Chapter 6.

4.3.1 Differences between the CLES results between the years 2009 and 2010

There were variations in the mean values of each of the scales between both years of the study. Comparisons of the earlier Figures 4.1 and 4.2 illustrate the subtle differences between the scale mean values in the year 2009 and the year 2010, respectively. The scale of Shared Control stood out and had low mean values in both years. The evaluation of the means of the actual and preferred means acted as a feed-forward mechanism to design intervention strategies with the teachers in the early months of each year.

4.4 ACTUAL AND PREFERRED DIFFERENCES

The CLES provided specific information about the students' actual perceptions and preferred perceptions of their learning environment. The initial administration of the CLES brought results for the actual and preferred means of the classes. The final administration of the CLES conducted later in the year brought results for the post actual means of the classes.

Table 4.5 reports the comparisons of mean scores for the actual and preferred Forms of the CLES over the entire sample in the year 2009. These were analysed for statistical significance using paired sample t-tests on differences between student perceptions of the actual learning environment and that preferred by the students. The actual and preferred differences were significant for most of the CLES scales.

Table 4.5

Means, Standard Deviations and tests of Significance of Differences Between 2009 CLES Actual and Preferred

	Mean		Standard deviation		Mean differences	
Scale	Actual (A)	Preferred (P)	Actual (A)	Preferred (P)	(P-A)	t Value
Personal Relevance	3.10	3.24	0.74	0.77	0.14	3.07*
Uncertainty	3.31	3.24	0.77	0.81	-0.07	1.26
Critical Voice	3.19	3.47	0.9	1.02	0.28	4.34**
Shared Control	2.22	3.08	0.95	1.01	0.86	12.42**
Student Negotiation	3.43	3.73	0.92	0.95	0.3	5.5**

*p<0.01, **p<0.001

N=327

Table 4.5 also reports the mean scores for the actual and preferred forms of the CLES 2009, the corresponding standard deviations, the mean difference of each scale between preferred and actual and the paired sample statistical t-values that were calculated on differences between the actual and preferred values. The actual and

preferred differences were significant for all the scales except the Uncertainty scale as shown in this table. Further to this the higher t-values of the scales Personal Relevance, Critical Voice, Student Negotiation and Shared Control show the greatest significant difference. These differences indicate the students' preference for a greater opportunity to: experience relevant everyday contexts in their science lessons, express their opinion in the classes, discuss ideas with their peers and plan their learning with the teacher.

Table 4.6 reports differences between the actual and preferred forms of the CLES in the year 2010.

Table 4.6

Differences Between 2010 CLES Actual and Preferred

	Mean		Standard deviation		Mean differences	
Scale	Actual (A)	Preferred (P)	Actual (A)	Preferred (P)	(P-A)	t Value
Personal Relevance	3.14	3.22	0.79	0.84	0.08	1.68
Uncertainty	3.08	3.25	0.84	0.83	0.17	3.36**
Critical Voice	3.39	3.58	0.99	1.02	0.19	2.88**
Shared Control	2.17	3.10	0.91	1.00	0.93	13.80**
Student Negotiation	3.46	3.60	0.91	1.00	0.14	2.31**

*p<0.01, **p<0.001 N=362

The actual and preferred differences in the year 2010 were statistically significant for all the scales except the Personal Relevance scale as shown in table 4.6. Further to this, the higher t- values indicate the scales of Critical Voice, Shared Control and Uncertainty show the greatest significant difference with respective t-values of 2.88, 13.88 and 3.36. The Student Negotiation scale still showed significance but with a somewhat lower corresponding t-value of 2.31. These differences indicate the students' preference for a greater opportunity to: express their opinion in the classes, plan their learning with the teacher and learn about science.

4.5 Using the CLES results for design of teacher professional development

It took time to define and unpack learning strategies that would fit with the specific scale. For example, the scale titled Shared Control, which was identified early on and seen as a learning environment perception to be looked at with depth because of the low actual values in both years. The Shared Control actual mean in 2009 was 2.22 and in 2010 it was 2.19. See Tables 4.3 and 4.4. The preferred means were 3.08 and 3.09, respectively, indicating no difference between 2009 and 2010. The Uncertainty scale with an actual mean value of 3.08 was another result that appeared low in 2010. Personal Relevance and Student Negotiation perceptions also appeared low in the years 2009 and 2010 with corresponding significance.

The CLES results were used to shape the teacher professional development sessions with the teachers over the year. By early Term 2 of each year the initial actual and preferred CLES data had been entered and statistics considered. A professional development workshop was planned around the results. In that workshop, teachers examined their individual class results and they would observe specific patterns of their own class, compare the statistics with other classes and the overall CLES statistics. In the teacher discussions, there was a consensus to focus attention on the entire set of scales, not just one or two that appeared low. Each scale was identified and discussed individually in the teacher professional learning to maintain a holistic nature of constructivist perceptions. However, over the course of the professional learning project there tended to be certain scales that seemed to require greater clarity and further insight to understand the learning environment more fully. It was easy to identify the need for change but not so easy to know how.

Discussions and evaluation from the teachers using the CLES results grew into a greater understanding of constructivist approaches in the classrooms. At times in the professional learning sessions there was attention for the teachers to listen to the teachers' beliefs and values on the subject of learning and for the teachers to have the opportunity to listen to different positions of learning theories. These reflective episodes in the professional learning sessions helped with implementing specific learning strategies to make positive change in the classroom.

The results of the actual and preferred CLES helped guide the inquiry in each year, they established and focused the discussion at the professional learning sessions. It was particularly poignant to have quantitative data at the beginning of each year. Teachers would quickly get a sense of their classroom climate using the data and the analysis provided specific foci to further investigate in their classrooms. At the professional learning sessions teachers were encouraged to discuss the range of the CLES scales.

4.6 ACTUAL AND POST ACTUAL RESULTS

Tables 4.7 and 4.8 present the statistical significance using paired sample t-tests with particular reference to the difference between the mean values of actual and post actual results.

Table 4.7

Mean, Standard Deviation and Tests of Significance of Differences between 2009 CLES Actual and Post Actual

	Mean		Standard deviation		Mean differences	
Scale	Pre Actual	Post Actual	Pre Actual	Post Actual	(Post-Pre)	t Value
Personal Relevance	3.12	3.4	0.71	0.84	0.28	4.42**
Uncertainty	3.32	3.35	0.75	0.80	0.03	0.48
Critical Voice	3.23	3.51	0.87	0.93	0.28	3.62**
Shared Control	2.28	2.5	0.98	1.00	0.22	2.86**
Student Negotiation	3.50	3.54	0.90	0.88	0.04	0.67
$^{**}p<0.001$	N=327					

Table 4.7 reports difference between the actual and post actual forms of the CLES 2009. It shows there was a statistical significant difference in student perception to Personal Relevance, Critical Voice and Shared Control. The mean difference between post and actual was 0.28 with a t-value of 3.62 for Critical Voice and the mean difference was 0.22 with a t-value 2.86 for Shared Control. This highlights the shifts in student perceptions over the course of the year.

The Personal Relevance significant difference highlights the specific input that was directed in the teacher professional development. In the workshops there was emphasis on the nature of curriculum design and how this could lift the Personal Relevance actual values. The learning programs were considered by the teachers to be a lever to engage the students and to provide authentic contexts that would help connect the students' world outside of school to what happened in science lessons. In the professional development the teachers shared current topics that they had designed to engage their students. Examples included world news events, a local environmental issue, a sports event, a current natural disaster. These purposeful curriculum decisions about the quality of the learning programmes are likely to have supported the changes to the Personal Relevance actual values over the year. Critical Voice and Shared Control actual values have also significant differences over the year 2009. The professional development sessions also provided the teachers with opportunities to share experiences of co-constructive classroom strategies. They encouraged critical review of teachers' beliefs and values around the practice of increased student voice in the classroom and their own positioning of this. The sessions included procedures and techniques to enhance student voice in the lessons and they provided actual qualitative student voice that was presented and discussed.

Table 4.8

Means, Standard Deviations and Tests of Significance of Differences between 2010 CLES Actual and Post Actual

	Mean		Standard deviation		Mean differences	
Scale	Pre Actual	Post Actual	Pre Actual	Post Actual	(Post-Pre)	t Value
Personal Relevance	3.15	3.32	0.78	0.77	0.17	2.70**
Uncertainty	3.12	3.21	0.84	0.83	0.09	1.34
Critical Voice	3.42	3.36	0.99	1.03	-0.06	0.81
Shared Control	2.20	2.29	0.91	0.94	0.09	1.31
Student Negotiation	3.46	3.35	0.89	0.96	-0.11	1.50

**$p<0.001$ $N=362$

Table 4.8 reports the mean scores for the actual and post actual forms of the CLES 2010 in a similar way. The greatest significance of difference is in the Personal Relevance scale with a t-value of 2.70. The Personal Relevance actual scale mean value was 3.15 and this increased in the post actual to 3.32.The scales of Uncertainty, Shared Control and Student Negotiation have shifted but only ever so slightly with a mean difference of 0.09 or more. The Student Negotiation scale has decreased from mean actual 3.46 to post actual 3.35, however none of these changes in the scales other than Personal Relevance were significant.

The actual Personal Relevance difference remains consistently significant for both years 2009 and 2010 perhaps due to the considerable input that went into curriculum design in the professional development with the teachers. The students Critical Voice and Shared Control differences were not significant in 2010 and little change in the mean values. This could have been that the teachers may not have seen the importance of these concepts and found the Personal Relevance easier to implement into their lessons.

4.7 GENDER DIFFERENCES

This section presents an analysis of the data to investigate how the students perceive their actual learning environment with particular regard to gender difference. All three forms including the actual, preferred and post actual of the CLES results were used in the ANOVA statistical analysis to look for patterns that may emerge for both male and female students.

In order to ascertain if there were significant differences between means, a t-value for equal variances not assumed was calculated. Table 4.9 reveals only one statistically significant difference between the girls and the boys in the year 2009 study and that was for the Student Negotiation scale. However, this value is particularly low indicating that there is little difference between male and female student perceptions. Generally, there is little difference between male and female perceptions of their learning environment.

Table 4.9

Summary of Group Statistical Significance for 2009 CLES Gender Differences

Scale	Mean		Standard deviation		t-test for Equality of Means	
	Male	Female	Male	Female	Equal variances not assumed	
					t	Sig.(2-tailed)
Actual						
Personal Relevance	3.14	3.08	0.77	0.74	0.62	0.54
Uncertainty	3.35	3.26	0.77	0.78	0.95	0.35
Critical Voice	3.09	3.28	0.96	0.85	1.81	0.07
Shared Control	2.32	2.16	0.99	0.93	1.43	0.15
Student Negotiation	3.28	3.56	0.96	0.89	2.64	0.01*
Preferred						
Personal Relevance	3.28	3.22	0.80	0.75	0.71	0.48
Uncertainty	3.30	3.22	0.78	0.83	0.83	0.41
Critical Voice	3.46	3.48	0.95	1.05	0.14	0.89
Shared Control	3.14	3.05	1.01	1.01	0.78	0.43
Student Negotiation	3.69	3.76	0.89	0.99	0.62	0.53
Post Actual						
Personal Relevance	3.39	3.36	0.84	0.87	0.33	0.75
Uncertainty	3.35	3.31	0.82	0.79	0.42	0.67
Critical Voice	3.43	3.52	0.95	0.94	0.74	0.46
Shared Control	2.52	2.48	1.03	0.95	0.30	0.76
Student Negotiation	3.44	3.66	0.88	0.88	1.97	0.05

$p<0.01$*

N=185females

N=142 males

Table 4.10 also presents a very similar trend in the year 2010 as to the year 2009 with no statistically significant differences between the males and females. The girls show increased values of Critical Voice and Student Negotiation compared to the boys and this was by 0.2 to 0.3 of the mean value in both actual and post actual results but this was not a statistically significant difference.

Table 4.10

Summary of Group Statistical Significance for 2010 CLES Gender Differences, A-Actual, P-Preferred, Post A- Post Actual forms

Scale	Mean		Standard deviation		t-test for Equality of Means	
	Male	Female	Male	Female	Equal variances not assumed	
					t	Sig. (2-tailed)
Personal Relevance (A)	3.16	3.15	0.79	0.79	0.02	0.98
Uncertainty (A)	3.24	3.03	0.81	0.85	2.16	0.03
Critical Voice (A)	3.27	3.52	1.06	0.9	2.17	0.03
Shared Control (A)	2.32	2.11	0.99	0.82	1.99	0.05
Student Negotiation (A)	3.4	3.53	0.87	0.93	1.24	0.22
Personal Relevance (P)	3.25	3.23	0.89	0.8	0.18	0.86
Uncertainty (P)	3.37	3.17	0.86	0.8	1.94	0.05
Critical Voice (P)	3.57	3.58	1.03	1.01	0.09	0.93
Shared Control (P)	3.09	3.08	1.00	1.00	0.10	0.92
Student Negotiation (P)	3.55	3.62	0.95	1.03	0.59	0.56
Personal Relevance (post A)	3.41	3.36	0.73	0.82	0.49	0.63
Uncertainty (post A)	3.21	3.25	0.88	0.77	0.42	0.67
Critical Voice (post A)	3.28	3.4	1.00	1.03	0.74	0.46
Shared Control (post A)	2.37	2.26	1.03	0.89	0.30	0.76
Student Negotiation (post A)	3.19	3.59	0.99	0.89	1.97	0.05

N=223 females *N*=139 males

The other scales such as Uncertainty and Personal Relevance indicate the opposite trend where the boys have slightly higher values in actual and post actual forms, with the Uncertainty scale. The scale of Shared Control presented a similar trend with some variation in the actual mean values compared with the other scales where the boys are 0.2 higher in most of their mean values. The actual Shared Control for the boys was 2.32, post actual was 2.37. For the girls it was 2.11 for actual and this became 2.26 post actual in the year 2010. This non-significant result may suggest that the male students perceive their learning environment as having more of an opportunity to plan activities with the teacher. It may also suggest that the boys perceive that they can make decisions about what activities they do with the teacher. However, the differences are not statistically significant.

4.8 ETHNIC DIFFERENCES

In this section, Tables 4.11 and 4.12 present results from the CLES over the years 2009 and 2010, respectively. The data have been examined for variation with regard to ethnicity and changing student perception of the learning environment. The overall CLES evidence suggests that NZ European students perceived their learning environment slightly more favourably than did NZ Māori and Pasifika students at the beginning of both years.

The aim in this case was to analyse how the differences between the three forms of Actual, Preferred and post Actual may have varied due to ethnicity. The ethnic differences that were distinguished in the survey were: NZ European, NZ Māori and other. The analysis was repeated using the ANOVA statistical analysis for both years 2009 and 2010. However, in 2010 the CLES survey was slightly modified to include the difference for Pasifika students and other students. Students in 2010 had an additional ethnicity choice on the survey script that distinguished between Pasifika and other. Tables 4.11 and 4.12 summarize these findings and the additional column where Pasifika and Other have been added appears in the Table 4.12 for the 2010 results.

Table 4.11

Summary of Group Statistical Significance for 2009 CLES Ethnicity Differences A-Actual, P-Preferred, poA-Post Actual

	Mean			Standard deviation			ANOVA groups	Between
Scale	NZ European	NZ Māori	Pasifika/0ther	NZ European	NZ Māori	Pasifika/other	F Value	Sig.
Personal Relevance (A)	3.22	2.92	3.04	0.70	0.85	0.60	5.26	0.01**
Uncertainty (A)	3.36	3.2	3.27	0.72	0.87	0.78	1.27	0.28
Critical Voice (A)	3.22	3.14	3.26	0.89	0.92	0.93	0.32	0.73
Shared Control (A)	2.19	2.35	2.15	0.90	1.04	1.03	0.99	0.37
Student Negotiation (A)	3.51	3.3	3.40	0.86	1.05	0.91	1.62	0.20
Personal Relevance (P)	3.4	2.98	3.03	0.73	0.78	0.72	10.01	0.00***
Uncertainty (P)	3.34	3.12	3.11	0.79	0.85	0.75	10.01	0.09*
Critical Voice (P)	3.58	3.3	3.34	0.99	1.04	0.96	2.30	0.10
Shared Control (P)	3.19	3.00	2.67	1.02	1.01	0.82	3.48	0.03*
Student Negotiation (P)	3.82	3.66	3.45	0.91	0.94	1.16	2.27	0.11
Personal Relevance (po A)	3.5	3.22	3.01	0.81	0.94	0.77	4.91	001**
Uncertainty (po A)	3.31	3.41	3.25	0.74	0.96	0.73	0.52	0.6
Critical Voice (po A)	3.49	3.49	3.45	0.93	0.98	1.03	0.02	0.98
Shared Control (po A)	2.43	2.67	2.34	0.95	1.06	0.98	1.70	0.19
Student Negotiation (po A)	3.61	3.49	3.55	0.88	0.93	0.87	0.45	0.64

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

$p<0.05$*

N=193NZ European

N=100 NZ Maori

N=34 Other

Table 4.11 reports the actual scale mean values for NZ European students were higher than for Māori and Pasifika students. The ANOVA testing values report greatest significance between ethnic groups for actual, preferred and post actual Personal Relevance values. On closer examination of Table 4.11 it reveals that these differences between ethnic groups were significant ($p<0.001$) for Personal Relevance. There was also a significant difference between the ethnic groups for the scales of Preferred Uncertainty and Preferred Shared Control but the significance was smaller ($p<0.01$). For NZ European students the actual mean values were higher, respectively, for all scales Personal Relevance to Student Negotiation. In contrast, the actual mean values for NZ Māori were lower respectively for the scales. The only exception was the Shared Control Scale where NZ Māori Students showed

a greater value. For Pasifika students, the mean values were significantly lower than the NZ European and NZ Māori in the year 2010.

Table 4.12 reports the CLES results for ethnicity in the year 2010. It indicates that NZ European students have perceived the learning environment more favourably than NZ Māori and Pasifika students over a number of scales. However there are no significant differences in the ANOVA testing values.

Table 4.12

Summary of Group Statistical Significance for 2010 CLES Ethnicity Differences

	Mean				Standard deviation				ANOVA Between groups	
Scale	NZ Europe	NZ Māori	Pasifika	other	NZ Europe	NZ Māori	Pasifika	other	F Value	Sig.
Actual										
Personal Relevance	3.21	3.03	2.78	3.24	0.77	0.80	0.79	0.85	1.97	0.12
Uncertainty	3.08	3.14	2.88	3.38	0.84	0.86	0.74	0.79	1.37	0.25
Critical Voice	3.44	3.50	2.77	3.28	0.98	0.93	1.02	1.02	2.21	0.09
Shared Control	2.20	2.14	1.94	2.43	0.89	0.91	0.86	0.97	1.08	0.36
Student Negotiation	3.55	3.32	2.92	3.60	0.88	0.96	0.96	0.82	2.99	0.03
Preferred										
Personal Relevance	3.30	3.12	3.02	3.21	0.8	0.92	0.81	0.89	1.08	0.36
Uncertainty	3.25	3.28	3.18	3.23	0.8	0.92	0.64	0.92	0.05	0.99
Critical Voice	3.57	3.56	3.38	3.71	1.04	1.00	0.86	0.99	0.33	0.81
Shared Control	3.10	3.03	3.12	3.07	1.03	0.99	0.99	0.85	0.08	0.97
Student Negotiation	3.63	3.34	3.80	3.87	1.02	0.94	0.8	0.98	2.42	0.07
post Actual										
Personal Relevance	3.39	3.29	3.33	3.56	0.75	0.90	0.70	0.73	0.87	0.46
Uncertainty	3.19	3.32	3.47	3.2	0.78	0.87	0.65	0.92	0.76	0.52
Critical Voice	3.37	3.31	3.62	3.29	1.06	0.92	0.91	1.05	0.35	0.79
Shared Control	2.34	2.23	2.66	2.14	0.95	0.96	1.11	0.86	1.02	0.39
Student Negotiation	3.51	3.29	3.12	3.46	0.96	0.98	0.81	0.84	1.31	0.27

N=223 NZ European

N=86 NZ Maori

N=18 Pasifika

N=35 other

Nevertheless, in the year 2010 the survey script was modified to distinguish between Pasifika students and other students. There were sufficient Pasifika students in this year to form a group. In the overall mean values presented in Table 4.12 the Pasifika students appear to be less confident in all the scales. NZ European students the actual value for Critical voice was 3.44 and for Pasifika students the actual value was significantly lower at 2.77. The Shared Control and Student Negotiation which are the co-construction scales appear lower than for the NZ European and NZ Māori students.

There are however some positive trends being signalled with regard to NZ Māori students in the CLES results. Over the course of the year in both cases and in particular reference to Table 4.12, the post actual results showed an increased trend in values well beyond the preferred values of the same scales. There was a dramatic increase in all scales for NZ Māori students at the end of the year with regard to the post actual mean values. The Shared Control scale became equal with the post actual value of 3.49 for both NZ European and NZ Māori. On the other hand this rate of increase in values was observed over all ethnicities not just for NZ Māori between actual and post actual results.

Table 4.12 also reports distinct variation between *other* students and the rest of the ethnicities. The precise ethnicity of *other* is unknown in this study however a very small proportion of classes did have Indian and Chinese students in attendance. The number of these particular students was significantly smaller than the majority of students in the classes. Figures 4.3 and 4.4 graphically depict the differences in the CLES mean values between the ethnic groups. In Figure 4.3 all the graphs of each ethnic group have similar patterns indicating there are similar perceptions across the scales.

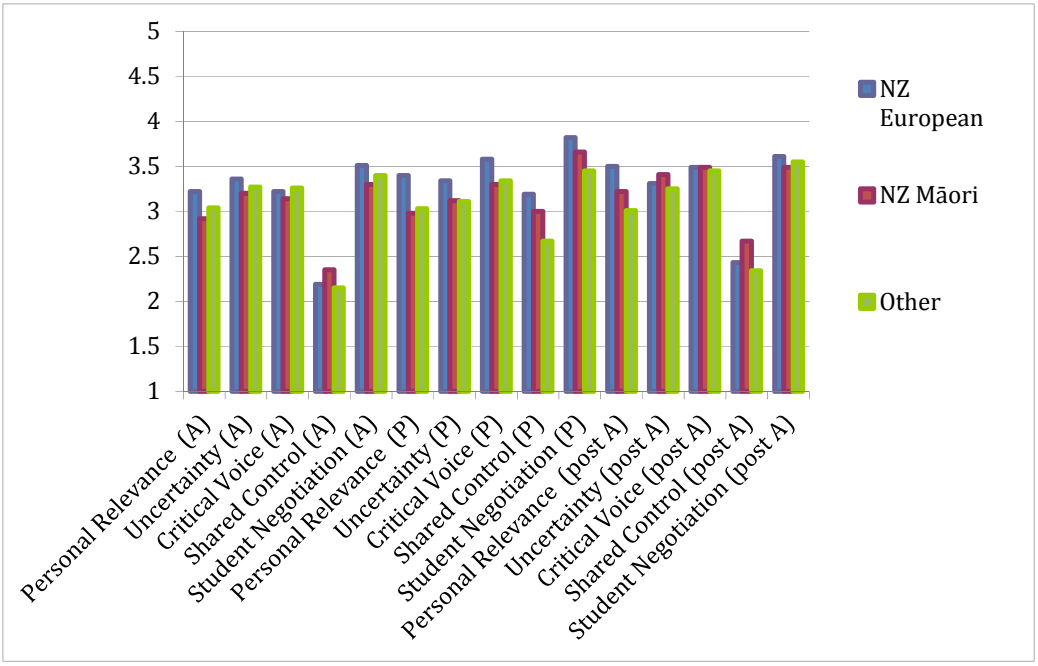

Figure 4.3. 2009 CLES differences in mean value scores for ethnicity groups.

The graphs' vertical positions highlight that the NZ European students remain at higher values across the scales. In addition to this the NZ Māori students also have slightly elevated mean values compared with the other students in the post actual scales. All the three graphs depicted in Figure 4.3 show an increase of mean values across the term of the year 2009 in particular reference to the post actual scores in all ethnic groups.

Figure 4.4 graphically depicts the mean values of the CLES across the scales in the year 2010 for ethnicity differences. There are four graphs representing the variation between the ethnic groups in Figure 4.4. In this figure the mean values of the Pasifika students have been separated from *other* students in the year 2010 sample which is different from the 2009 sample. All the graphs show similar patterns with the distinctive dip in the Shared Control mean values. The NZ European students show slightly higher mean values than their NZ Māori peers. The NZ Māori students also show slightly higher mean values than their Pasifika peers.

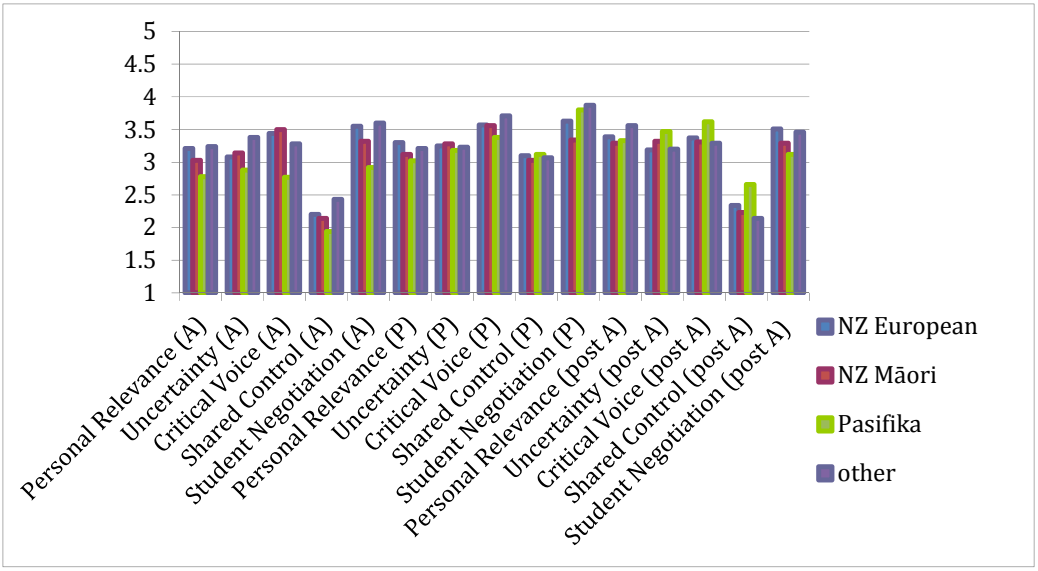

Figure 4.4. 2010 CLES differences in mean value scores for ethnicity groups.

4.9 CHAPTER SUMMARY

There are four conclusions that can be deduced from the results presented in this chapter. First the statistical significance of the differences of the preferred and actual CLES scales with particular attention to the Shared Control, Critical Voice, Personal Relevance and Student Negotiation with greatest significance in the Shared Control scale. These statistically significant differences highlight the students' preference for greater opportunity to: experience relevant everyday contexts in their science lessons, express their opinion in class, discuss ideas with their classmates and help plan their learning with their teacher.

Secondly the actual and post actual CLES results report statistically significant difference in student perceptions to Personal Relevance over both years 2009 and 2010. There were other scales that showed signs of difference but not as statistically significant as the Personal Relevance scale. This particular scale was shown to be the one scale that shifted with greatest difference over a year than the other scales for both years 2009 and 2010. The corresponding teacher professional development that occurred through the year had much emphasis on curriculum design with respect to authentic and relevant contexts, this emphasis may have led to the significant statistical shift.

Thirdly the results from the CLES with respect to gender differences generally revealed no statistical difference between the girls and the boys across all scales and over both years. In conclusion, there was little difference between male and female perceptions of their learning environment. However, the Student Negotiation scale did show a small statistical significance but this was only in the year 2009 and not in 2010. This indicated that there was greater perception of Student Negotiation with respect to the girls than the boys.

Finally the results from the CLES with respect to ethnicity differences revealed statistical significance in the Personal Relevance, Uncertainty and Shared Control scales but only in the year 2009. There were no significant statistical differences in the year 2010.

CHAPTER 5

PRESENTATION OF QUALITATIVE RESULTS

5.1 CHAPTER OVERVIEW

This chapter presents the qualitative data obtained from student interviews, teacher interviews and the student learning drawings. Section two pays attention to what students have to say about their experiences of science learning in their classes. The student narratives help build on the CLES findings and develop further insight into student perceptions of their immediate learning environment. The interview questions are developed around the five central scales of the CLES. Section three presents some samples of the teacher narratives from the teacher interviews that took place at the end of each year. In general, the teacher conversations were informal and they spoke candidly about their perceptions of life in a science classroom with their students. Section four presents a sample of student learning drawings; they have added further qualitative detail and the images present different views of learning from a selection of students in the science classes.

The section on the student interviews presents a selection of excerpts from the audio interviews, where five interview questions were posed to the students. There is interpretation of the excerpts and discussion in terms of the CLES scales, for example Personal Relevance, Uncertainty, Shared Control etc. The section on the findings of the teacher voice from the teacher interviews focuses on three themes: relevance in learning, student relationship interactions and professional learning. The chapter then proceeds with a section on the findings of the student learning drawings as further qualitative evidence. A sample of ten student learning drawings has been selected and presented with analysis in this section. The final section is a summary of the overall qualitative finding.

5.2 STUDENT INTERVIEWS

Introduction

The voices in the following sets of narratives come from groups consisting of two to four students. There were 67 interviews that took place and all students interviewed were in either Year 9 or Year 10 levels. The students were given the question before a response was taped and this seemed a comfortable method of practice for them. Usually, the students did not need any further clarification of the interview questions and they generally warmed well to the interview process as it proceeded. Sometimes prompting questions were asked to help explore the question in further detail for the researcher's purpose (see Table 3.3 for further details of the interview questions).

In general, the students needed time before they were ready to speak openly and unaffectedly with the researcher in front of their peers. Hence, there was no time restriction given to the interview process. The researcher began the interview by introducing himself and he gave an overview of the project. At this point, students were able to ask questions so that they had a clear idea of the purpose of the interviews. All students in each of the classes had written information that was sent home detailing the overview of the project at the beginning of the year and the set of interview questions was handed out in class a few days before the interview took place. At the beginning of the interview the students were told that it was entirely voluntary and they could opt out at any time.

All names and places mentioned in the following narratives were created to protect the students' confidentiality. Fictitious names have replaced the real names to protect student identity in the narratives. There was no identification of student name, ethnicity or gender on the audio-tapes except for numbers and dates to manage the recordings.

The rationale behind the collection of the student interviews was to build on the students' responses to the CLES quantitative survey. The nature of the audio interview questions was couched to explore qualitative detail of the students' attitudes and perceptions of their experiences in science. What was anticipated was a

different perspective of the learning environment that could be triangulated with the CLES data and the learning drawings. Furthermore, the main purpose was to provide further material that may support a robust response to the original research questions:

1. What are the students' attitudes and perceptions of their experiences in year 9 and 10 science?
2. How could the learning environment be changed to improve students' attitudes and perceptions?

Each of the five interview questions was linked with the CLES survey under the five scales, namely, Personal Relevance, Uncertainty, Critical Voice, Shared Control and Student Negotiation. They are as follows:

How relevant do you see the learning that goes on in your science class to your everyday out-of-school experiences?
Are there opportunities in your lessons that you and your classmates help the teacher plan the learning and decide on activities?
How do you think science has changed over time?
How comfortable are you with expressing your opinion in class?
Tell me about the opportunities you get in explaining your ideas in a science lesson?

The questions were consistently used throughout the time in all the audio-taped interviews over the course of the research.

Personal Relevance

Learning about the world outside of school in their science lessons is a step for students to connect their everyday experiences with the science learning going on in the classroom. As shown in the previous chapter, personal relevance in classroom activities has been seen as a significant link to positive student engagement in much recent academic literature. Perhaps at another level, students begin to sense that learning about science is inextricably connected with their real world and this happens not just at school, but at home, when they are at the skate park, playing netball, having dinner, etc. However, what is sometimes not observable to students

and their teachers is that these connections between the science activity and the real world context are not clearly understood or perhaps not clearly demonstrated. Authentic contexts such as these may be implied in science teaching but can often be lost in the everyday business of laboratory activities and lessons. And as we hear from some of the following narratives, students can become disengaged in their learning because they do not see the relevance of what they are doing in class to their world outside of school.

One of the early items in the CLES instrument that was administered in 2009 is: "**Our new learning starts with problems about the world outside of school**". Students were asked to rank this from 1-5, with 5 indicating "almost always" and 1 indicating "almost never". In the overall results of the 2009 actual form sample, 81% of all the students in over 15 schools indicated that they almost never, seldom or just sometimes found this to be true of their experiences of science learning. And interestingly, this value did not change in the 2010 sample. This particular item also had the lowest mean of 2.77 out of 5.0 in all of the five items concerning personal relevance.

So what we have here is an interesting situation. There maybe increasingly more emphasis for students to learn about real world issues in their science lessons but the students were signalling that this rarely happens in their lessons. The following selected excerpts reflect this theme of personal relevance. The question was:

How relevant do you see the learning that goes on in your science class to your everyday out-of-school experiences?

A group of three students began by telling some of their experiences.

> *Some things we're doing in class relate to and is happening in the world either at the time or it's happened recently. When you're sitting there at home and watching the news on TV, and you're thinking -how does that work? It's really cool because you know how it works. We watched the Tsunami on a Youtube clip (in class), and all the destruction and the people being swept away. For the Tsunami project we learnt a lot about Tsunami warnings and the plates*

moving together. With the reproduction debate- it was quite interesting because we weren't usually thinking about that, we had the chance to see the other side, we always thought the negative, it was quite challenging, quite different. We had to fight for the things we didn't believe in, which was a bit strange.

The significance of this excerpt is how the students identify with real world contexts that they believe are connected to science learning at school. A feature of this highlights the concept of relevance, where the students' awareness of the connections between real world activity seen on television to their learning going on at school. For example, current news on television that they maybe exposed to at home and what they sense are links with science lessons. It is also noted that when those lessons use current events for example the Tsunami in the lesson, the student identifies the connections with real world issues. The specific use of authentic contexts by teachers in science lessons are remembered by the students. Another feature of this narrative reveals how the students relate to controversial debate or taking sides in an issue, which may involve their own personal beliefs such as the example the reproduction debate. It is noted that if there are opportunities in science lessons that students can see their point of view and with opposing views, they can become more involved in the lesson. Generally this group of students imply that some contexts are being used in their science lessons that they see as personally relevant.

In another interview from a different class, their responses to the same question involved relevant real world contexts such as cars or car speeds. However, their mixed attitudes to their immediate learning are noted as frustrating and unrelated to their personal interests, not because there were no contexts being investigated but more because those contexts may not have connected with their life outside of school. The opportunity in the lessons to bring the students own world of knowing and experience into the classroom is not heard from this student voice. In particular, these students in this narrative do not see the relevance of the task of note taking from the whiteboard and their immediate learning. They talk about being bored from the constant chore of taking notes that maybe unrelated to their own questions or perhaps not seen as meaningful to them. The personal relevance of the lesson in their

eyes can somewhat be lost due to the frustration of the lesson not connecting with their expectations of relevance in the lesson. The teacher may have decided that the topic is about cars and car speeds but have they responded to specific contexts that maybe more relevant to the students? It is interesting to note that personal relevance is closely connected with the teacher sharing control with the students because of the co-construction of the design of the lesson providing greater choice and input from the students. Provision of further opportunities in the lessons may help students ask their own personal questions and become more fully engaged with purpose when they can make choice. In the interview the student spoke about how he wanted to have more input into what was relevant for him. The teacher may have had the best intentions of providing stimulating topics but the student didn't feel that these were negotiated with him. This selected excerpt describes how the student willingly participates in science but there is a sense of disconnection, perhaps due to the amount of copying from the whiteboard.

> *We made ginger beer, that was cool and I really like the hands on stuff. But most of science is pretty boring because we do a lot of writing. There's a lot of writing in science and we have to copy out the notes on the white board. We timed how fast toy cars went down a ramp. We had to work out whether friction slowed down the speed of cars, it was about the surface, friction. We also went outside and measured 30 metres down the roadside and we timed the cars. We did a whole unit on cars but I didn't find the topic interesting.*

Does the learning connect you with your interests?

> *Some……, I like space and I like cars but not really.*

What could we do to help you learn more about space or cars?

> *Well, we could go on a class trip to the V8 racers in Hamilton. There's a car race soon and they set up road blocks so people can watch the cars. It's cool.*

Being responsive to students' requests within the topics may help them feel greater engagement with purpose in science lessons. It is apparent from this request of going

out on a class trip could motivate the student and greater engagement may transpire. Another student in the interview states that they like cars and space but the actual learning generally does not really connect with their own interests. We sense the decisions regarding the choice of topics come from the teacher, not the students and the experience of shared and negotiated learning contexts could be developed in the science lessons. The following selected excerpt describes how this student requests how he would like to find out more about the world. He would like to learn about environmental effects and the implications of this learning can help him connect with the realities of world issues.

> *I like to know about what's happening around the world and how it affects us. I like to learn about pollution. Learning about the ozone layer. How we are polluting and stuff? This can connect you to the real world if you want to be an activist.*

In another interview with different students although from the same class, the question was couched a little differently.

Are there things that you learn about, that are relevant to your life?

> Jesse: *Sort of, I liked the space topic but the cars didn't do it for me. If I had a choice I would do muscles. I'm into swimming, I'm an all year swimmer and I'd like to know more about muscles and how they work. Sort of sports performance.*

This excerpt captured how the student wished to explore her own personal interests in science lessons especially her interest in swimming. Another student, also in the same interview, speaks passionately about her personal interest in history.

> *I'd really like to learn about Egypt, pyramids and mummies but we didn't do anything like this. I like the science mysteries. Me and my Dad have this scrap book and we've collected cuttings and information about mysteries, lost civilizations- I really like this. Old ancient things. How the people have lived and made the pyramids.*

A Māori student in another interview, talks candidly about his lack of engagement of the topics they have studied in science. Inviting Māori students to bring their experiences and personal interests to the learning might also help Māori students to feel that they, as Māori, are being valued in science lessons.

> *Science is boring. I don't like the writing, the cars topic was boring.*

What kind of topics would you like to study?

> *Rugby and sports, touch rugby. I don't really know. (*long pause*) I like the practical things where we can make things and investigate how things mix and react. I like topics that the teacher is excited about. If I was a teacher I would teach topics that I was excited about and I would make sure I would ask the kids what they were interested in. What they do outside of school. It would make the lessons more interesting. Instead of just writing all this stuff down, actually doing things that are interesting.*

In another excerpt, the students highlighted how certain contexts being used in their lessons helped them connect to the world out of school. Plotting the progress of the nuclear accident in the wake of the 2011 Japanese Tsunami and following the progress of teenager Jessica Watson sailing solo around the world facilitated much of the discussion about relevance.

> Aroha: *The bio-dome was great- we had to build a model of a bio-dome that was going to keep 30 people alive for two years in Thames. There was a scenario where there had been a nuclear accident and for people to survive there was a dome built to protect them from the fallout. We had to make this model of a dome on a piece of cardboard and make all the animals, plants and buildings that would go in it. I really liked that, it was practical and creative. It was really creative. We knew it could really happen and this was a chance to work out the problems.*

> Mahara: *Yeah, learning about Jessica Watson was neat, we learned about how she navigated and what she ate. We used the internet to see where she was.*

Do you have these world issue topics all the time through the year?

> *He* (teacher) *shows us current things that are happening in the world. We are working hard and I think he knows we are learning. When we were doing the dome he asked us questions about what we were going to put into it. Decide on the animals and solar power. Where to put them, that sort of thing.*

This evidence suggests that certainly there are relevant contexts being used in classroom practice and these are particularly dependent on the teacher deciding on them.

In summary, there were mixed perceptions about the subject of science offering relevant real world experiences for the students to learn about in their studies. What was most apparent in the interviews was the students' desire for world relevance in their lessons and the opportunity to choose it. The students offered candid responses to what contexts could be used in the lessons and there was considerable zeal in discussing their personal interests and how these could link with science. Sadly, some students remained disengaged and saw no relevance in learning science to their out of school experiences or world events.

Finally, it is interesting to note that the shifts in the 2009 CLES of the early item number 2 which was discussed earlier: "**Our new learning starts with problems about the world outside of school**". The mean score out of 5.0 of that particular item in the actual form was 2.77, the preferred form was 3.03 and by the end of the year this had climbed to 3.19 in the post actual form, greater than the students' preference. Hence, the students' perception of the idea that new learning would start with problems about the world outside of school had significantly increased over the year. Perhaps this was due to the heavy emphasis placed on relevant current topics being explored in the teacher professional development over the course of the year.

Uncertainty

To learn that science has changed over time and that science is influenced by people's values and opinions can be challenging ideas to young students' beliefs and

values around what science is and how it changes. This particular scale of Uncertainty happens to link with the overarching Nature of Science strand titled "Participating and contributing" in the NZ curriculum. It is an area of the NZ curriculum where there has been much discussion around the social implications of science teaching in the classroom. This perhaps has not always been the case in the past, where emphasis was placed on science being taught as a series of sacred facts and fixed methodologies. The recent NZ curriculum focuses attention on students developing an understanding of socio-scientific issues by gathering relevant scientific information. The document also goes onto to describe that students are expected to "Come to appreciate that while scientific knowledge is durable, it is also constantly re-evaluated in the light of new evidence" (p. 28, Ministry of Education, 2007). This particular strand of Nature of Science can be easily misinterpreted to be students actively involved in their learning and making a contribution. This idea of making a contribution in class will be explored later under the headings Shared Control and Student Negotiation.

A pair of students Emily and Sophia begins by telling some of their thoughts about how science is changing. The question posed was: Tell me what you think how science is now, compared to science long ago?

> Emily: *We know a lot more now, there's more knowledge now. There's more problem thinking, trying to figure things out. There's more advanced thinking which I suppose has come from the early scientists and built up.*

The other student speaks up in the same interview.

> Sophia: *Yes, I think science for me has changed a lot. I need to find out more, go on the internet and see how things work. It changes every day. Science now is high tech with heaps of computers and digital machines to process information. I think way back in the olden times they did more simple stuff like measuring with rulers and watches. They were pretty curious about things, weighing things, measuring things. Now it's all computerised.*

A feature of these excerpts is that they are aware that science is changing. They perceive science to be different now to as it was in the past. Sophia also points out that measurement in the past was with rulers and watches with regard to basic phenomena. She also notes that scientists were curious about the world and they tended to quantify their curiosity by measuring. Sophia describes science currently using computers and digital technology to process the measurements. This is an interesting reflection from such a young person.

Another student Paul from a different school describes how science is changing and that those changes can benefit mankind. He describes how his mother was unwell and he links the medical intervention that she undergoes with technological change. He also talks about the idea of knowledge building up and accumulating over time. One other feature of the narrative is that he speaks about his teacher as knowledgeable and he himself acquires science ideas from his teacher. Here are some excerpts from the interview.

I think science has really changed since the old times, like it builds up the knowledge over time. There are more practical things that can help people especially in hospitals. My mum got sick last year and she had to spend a lot of time in hospital. A specialised doctor looked after her and he used machines to scan her. They could find out what was wrong……

I think my science teacher knows a lot, he explain the ideas and tells us stories about how science has changed, from dinosaurs to space technology.

A group of three students from another school add to further insights about Uncertainty. They are the only group in all the interviews that used the names of scientists e.g. Rutherford. Again, they sense that there have been some significant changes from the past and that the scientists make the changes. Another feature of this narrative is that they bring up the idea of discovery. They describe the scientists as discoverers of new knowledge, inventing new technology with the use of new materials.

The change has been pretty amazing,…. a lot. Yeah,… Like Thomas Eddison- he invented the light bulb, Einstein and Rutherford made changes in science. They have also discovered new minerals to use in equipment like titanium, it makes things stronger.

We have computers that can pretty much do everything for us now. Everything is much more advanced. Albert Einstein and Ernest Rutherford - he split the atom.

John: *The equipment has changed, the technology, it has definitely improved; it gives us a further insight in whatever you are studying. We have a better understanding of sickness. Stephen Hawking and that old guy… Newton have made changes to science.*

This last quote from John in the same group of the three students reveals the idea of technology improving with time. He talks about the changing nature of the technology can be refined and developed into a better product. John describes science as connected with technological change and with the process of advancing equipment to offer greater detail and insight into a study.

In summary, the narratives of the interviews uncovered some interesting patterns emerging from students' perceptions about science changing. Most students were acutely aware of the rapid changes to technological products in their everyday lives. They related these changes through science intervention. They also commented on the influence of scientists taking on the role of change agents. They spoke of the discovery of new materials and how scientists can make this happen. However, in most of the interviews very few students identified scientists, they mainly discussed the changes to technology. Not many could name a scientist nor could they identify the role in what they did to make change. There were 67 interviews conducted and only in one interview did the students discuss the actual names of scientists. Some students such as Emily and Paul spoke of science as factual and sequential; that learning about science for them was building knowledge of facts and collecting knowledge. Some students reported that modern science is very different to long ago and learning about it was predominantly through the use of the internet and the

knowledge of the teacher. The internet and the associated computer technology were considered sources of science knowledge.

Shared Control

"Learning to learn" is the title of the scale of Shared Control in the CLES survey and this describes the extent of planning the students do with their teacher. The act of being invited to share with the teacher, control of the learning environment is somewhat daunting for students to understand let alone practice. For many students, this seems foreign to the way of life at secondary school where predominantly the lessons and learning programs are pre-determined by teachers. The teacher "being in charge" seems to be the role that many school cultures wish to impose and the idea of students helping plan activities or deciding on what to learn could be perceived as foolish and wasteful of their teaching time. Furthermore, some Māori and Pasifika cultures consider that the teacher has an automatic right to complete control of the learning process otherwise there is a perception that student misbehaviour could develop and students could show disrespect for the teacher. In the Pacific islands, teachers are mostly held with utmost respect. Many of the Pacific island families immigrating to New Zealand still retain this sign of respect of teaching authority and would question the idea of students sharing control with the teacher.

This following excerpt comes from two Māori students illustrating the students perception of the teacher taking the main responsibility for the learning and planning the learning. They are keen for the teacher to take control of the learning environment and would rather be told what to do in the science lessons. This short excerpt taken from a lengthy narrative is towards the end of an interview with much discussion earlier between the two boys on who makes the decisions about the learning, the teacher or the student? The question posed was: Are there opportunities in your lessons for you and your classmates to help the teacher plan the learning and decide on activities?

……I think it is important that teachers do the planning, because, I mean if they just let us do our thing there will be chaos. I think it is easier for me to go along with what the teacher says and I'll do it. Like, if you know what the teacher wants and it is

clear I'm glad. I would rather have the teacher tell us otherwise we could do something dumb.

Other students however, are frustrated by teacher domination of the learning process and prefer to be more involved in the planning as shown in the excerpts that follow. This particular scale titled Shared Control in the CLES is the lowest scoring scale in all of the five scales in both years 2009 and 2010. In the 2009 results, the mean value out of five is 2.23, preferred is 3.08. The 2010 results show similar patterns, the values 2.19 for actual and 3.09 for preferred. The results of the survey show a wide gap between **actually** having shared control and their **preference** of having shared control. 89% of all students in the 2009 indicate "almost never to sometimes" in the item "**I help the teacher to plan what I'm going to learn**". Of these, 39 % of all students in the entire cohort surveyed in 2009 indicated "almost never" to this item. In 2010 the results show 41 % of students indicate a similar attitude. So the results clearly show a yearning from the students to work with the teacher in being more involved with the decision making. The **preferred** results seem to back up this claim and in both 2009-2010 surveys, the value drops dramatically to 14-15% indicating "almost never". The shift suggests a wide gap between what's actually happening and their preference for helping the teacher plan. What seems to be very noticeable from the students' quantitative results is the desire for change. The following student responses help to expand further on these students' perceptions with respect to the question posed in the interview:

Are there opportunities in your lessons for you and your classmates to help the teacher plan the learning and decide on activities?

A group of students begin the conversation in answering this question.

> *We would like to have more say in what we do. I think (teachers) they have to want us and let us have a say. Our teacher would get upset if we helped her plan the activities. She would think I am the teacher and you are the student and put us in our place. I know that she knows heaps of stuff about science and I should learn stuff off her but… I still think we should have more choice for us to do the topics we want.*

In the excerpt a theme develops where the students are keen to have more input into their lessons. They talk about the teacher having the potential to become annoyed if they were to help plan out activities with her. The students sense that the teacher takes the dominant role of organising the learning and that the teacher assumes the main control of what goes on in science. They go onto describing how they would like to have greater choice in the topics in the science lessons. From these descriptions, there seems to be a tension between where the students are wanting greater autonomy in the science lessons and the teacher is keen to retain the majority of decision making.

Another student from a different class and this excerpt is taken later in the interview with the same interview question. She begins to describe how working in a group helps them plan out what they are going to do. Their planning tends to be together and there is a sense from her descriptions they have more autonomy in their lessons due to greater opportunity to split up jobs and share work. Another feature is that they have worked out how they can complete activities successfully knowing the strengths of each person in the group:

> *I enjoyed working in teams, this gives us some chance of planning, it's been a lot different - the teacher is not always at you, we get to work in teams. I like the dissecting. We've got strengths and weaknesses and we divide up the jobs. Everyone has to pull their weight.*

Another question is posed to the same group

Are you given the opportunity to help the teacher plan the lessons, actually make the lessons?

> *Some, but not much.*

> *We get to plan what to do in an investigation, like what we will need, like equipment.*

Are you able to challenge the teacher in any way?

Probably not
I don't think so

In these excerpts the students convey that they seldom make decisions about the lessons and that the teacher generally takes overall responsibility in the make up of the activity. Earlier in the interview the descriptions indicate opportunities to plan together as a group on how the activity can be completed or performed. However, when questioned about the chance to plan the actual lesson they do not get this opportunity.

Another interview at another school, an interesting conversation develops between three girls. This is a short excerpt selected from the interview.

When we are in groups working on something, we have more power over what we can do. I know the teacher thinks he is the boss but really we do what we want. We talk about it together and we do it a lot quicker. We kind of plan out the different things to do, while talking. We share the load.

In this interview the three girls described how the opportunity to working in a group helped them make decisions about what they are doing and what they are going to do. They talked candidly about how their teacher assumes the main control of the lesson but they also possess the confidence to make their own decisions within the learning. A feature of their perceptions about the planning was that they also liked to share ideas first, sorting out who does what and then they get on with the task.

Another question was posed to them later in the interview: How do you think you could help your teacher decide on which activities are best for you in the group?

The group idea is cool and we should have it always. We could make up a list of things to do and see if he wanted us to do those things. We are doing chemistry right now and I like the reactions. Sometimes I would like to do them again, but the teacher won't let us.

This feature of the balance of power between teacher and students rises again in this excerpt. The girls seem content with working together in a group and they provide a list of ideas to which the teacher could look at and negotiate with them. However, they shift the conversation to the subject of chemistry and their request to repeat practical experiments, asking their teacher if they could do this.

Another student from a different class discusses the merits of working in groups. He describes the opportunity of having tension even conflict in the group, helps them keep thinking about fresh ideas. He sees this as a positive thing when planning out work. His group has varied opinions and mixed beliefs about all sorts of issues and he believes this contributes to a healthy group. Here is a short excerpt from the interview.

> *When you are working in a group you all get a say in what you are learning about. There are heaps of opinions that you can join together. We fight a lot but it's good and it keeps us thinking about new ideas.*

Another question is posed: Tell me about how your group could plan activities? In this next excerpt he goes on to saying how they collect ideas and how they interact with the teacher in the lesson.

> *We could use the whiteboard but that's really for the teacher. But sometimes we use poster paper and brainstorm our ideas down. The teacher comes around and looks at what we have done.*

What does the teacher say when they come over?

> *He asks us questions and gets us to write more things down.*

What do you do when you finish?

> *We pack up. I usually keep the notes we've written and keep the paper, Mr B doesn't read them again.*

Another interview, which describes the teacher using different strategies providing greater opportunity for the students to plan out what they would like to do and to make decisions about their learning. The students talk positively about the chance to decide on where they would like to go on a class trip. They also describe the opportunity of having choice in the science lessons was a good thing for them, where the teacher poses a number of options. A feature of this particular interview was the students' enthusiasm of their own self-belief that their group was much better off making these decisions than if they were working individually. The teacher was described as an encourager of ideas and someone who they could go to, to negotiate ideas and make plans with. They talked about planning out topics on paper and this seemed to give them freedom over what they would like to learn about.

> *We went to the observatory in Wellington, on the bus, it was very cool. Mrs D asked us what we wanted to do in the year and we told her we wanted a trip. We made a list of places and things to do on the board. We chose our own groups and I like making power-points and videos. Mrs D lets us have a choice about the topics. She shows us her teaching book and puts up the list on the screen, and we can talk about what we would like to do. When we are together in a group we get a say in what we can learn. We plan out the topic on some scrap paper and show this to Mrs D. She says whether we can go on. She encourages us all the time.*

Do you like this way of teaching?

> *Yes we like this, it gives you freedom. I like science.*

Do you think it's the teacher or the subject that you like?

> *It's both.*
> *Yeah, it's both.*

The students from one class highlighted the interaction between teacher and students.

> *Yep, in science, it can be enjoyable, but usually it's not. Most of the time it's writing… taking notes. But when he lets us do experiments, it becomes more practical, a lot more interesting. I learn heaps more. Like when we were doing chemical reactions we could do any of them in any order. Mr T got out the equipment and chemicals. We made up our own questions and he came around and asked us questions too. We can see it for ourselves and do it. Sometimes we get it wrong and we have to start again, but that's how I like it.*
>
> *It's much more interesting than just watching him doing it.*

In this narrative the students explain the importance of the students performing the practical experiments rather than the teacher demonstrating the practical task to the class. They also describe the significance of making up their own questions and trying out different methods even though they could be wrong. They also respond positively to having choice in the lessons.

Another question was posed to them. Do you like the teacher coming around and talking to you when these practical activities happen?

> *Yes we like it when he comes over, he talks to us about the chemistry but also about lots of other things. We can ask him questions and it's not embarrassing. It's not like the whole class.*

In summary of this Shared Control section, there are three features that are revealed from the interviews. The first is that the students welcomed having choice in the lessons. They talked candidly about the teacher giving them options and that they could choose out of a list of topics. The second is that most (but not all) the students wanted a greater degree of autonomy in the lessons particularly with planning the lessons with the teacher. Many described the opportunity of having a chance to plan out what they were going to do was seen as important for them in their learning. The third feature is the opportunity for them to work in groups, this was seen as

empowering for them, to make decisions and share control with their classmates and their teacher.

Critical Voice

In this scale the interview questions were about how comfortable the students felt about expressing their opinions in class. Was it acceptable for them to question ideas that are being taught? This scale was described as "Learning to speak out" in the questionnaire.

In the CLES results for 2009 and 2010, the Critical Voice mean actual values were 3.20 and 3.41, respectively, out of 5.0. They are higher values when compared to the other scales and therefore perhaps the students' attitudes overall seemed positive about their experiences regarding expression of their opinions. The following sample of narratives explores this further.

How comfortable are you with expressing your opinions in class? Could you challenge the teacher?

> *Sometimes*
> *No, not really, it depends on the subject*

What do the rest of you think about that?

> *Yeah, I think, it depends on the mood of our teacher. I call out quite a bit in class, sometimes I put my hand up to ask questions. There are some students who are too shy.*

A Māori student.

> *Yes, I can express my opinion in class but I can only challenge the teacher sometimes. I'm happy in class, it's ok. I can ask the teacher to make things clear. We don't get the chance to kind of debate ideas or question her.*

Generally, the students in most of the interviews spoke of the freedom that they had to speak out in class. In this particular excerpt from a Māori student, he describes the learning environment as positive for him and that he has opportunities to voice his opinion in class. However, he also describes he does not get the opportunity to debate issues or question the teacher about the ideas she is talking about.

Students from another class.

> *Mrs B is pretty honest with us. She speaks her mind and we speak our minds. I like this. I'm not embarrassed if I don't know the answer. She really listens to us. I like teachers who ask us questions and want to find out our opinions. There are other teachers who don't like asking us questions, they think it's stupid and move us on.*
>
> *Mrs B responds to our questions. She can see both sides to arguments. She listens to our opinions.*

In this interview the students describe the importance of the opportunity to be able to speak their minds and voice their own opinion in class. They respond positively to the way the teacher listens carefully to them and that she asks them probing questions associated with their thoughts. Their voice is valued in the lessons and they enjoy asking questions, exploring ways to challenge the teacher and get her involved in their own questions and thinking.

Finally, a student from another group describes the significance of researching knowledge from the Internet and how it can help inform their opinion, backing it up with details. They also describe having the opportunity to see other opinions and view-points helps them express their own opinions in class. Here is a short excerpt from the interview.

> *It's a lot easier to express your opinion when you are researching. Because you see other opinions and viewpoints on stuff. Your opinion can count because you can back it up with facts. When you are using the internet, you can question it.*

Student Negotiation

This scale in the CLES is titled "Learning to communicate". It assesses the extent to which opportunities exist for students to explain and justify to other students their newly developing ideas.

In the year 2009, the mean value out of 5.0 for Student Negotiation was 3.44 and in the year 2010 it was 3.47. This particular scale had the greatest mean in both years. This shows that the students in the classrooms have confidence in discussing and explaining ideas with their classmates. However, the preference mean values increased to 3.74 in 2009 and 3.59 in 2010 showing a trend where the students preferred to have greater communication with their peers than what actually occurs in their classrooms. There was statistical significance in the CLES actual and preferred results with respect to the Student Negotiation scale in both years of the study.

The following excerpts of the interviews further explore the students' perceptions of how they communicate with their classmates. Negotiating discussion with classmates can be a challenging task for teenagers, particularly when the conversations depend on their own confidence to speak up and negotiate discussion. There can be a lot of activity going on in science lessons in terms of practical activity, methods to follow and classmates in close proximity to one another. Hence, there are challenges for students to negotiate conversations with their peers. Some of the following excerpts taken from the interviews reveal strains when it comes to explaining their ideas to their peers. This question was asked: Tell me about the opportunities you get explaining your ideas in a science lesson? An excerpt is taken from the full interview.

> *Our class is pretty disruptive, like they will run around, they wouldn't listen to what I said anyway.*
>
> *Yeah* (agreeing)
>
> *Yeah* (agreeing)

But in our group we talk about the ideas and share information.

So you get a chance to talk to everyone in your group?

Oh yeah. Our class is pretty immature, but we can do our own thing in the group. We can share the workload.

These excerpts describe how the students coped with a demanding class by using their own group to get on with work and talk about ideas. They spoke of sharing ideas and the work that was asked of them by the teacher. A general feature of this interview was the students discussed the importance of their group being able to shelter from the noise and distracting nature of the whole class. They appreciated being in a group to take control of the learning and make decisions by themselves.

Another response below from students in a different class indicates similar perceptions of sharing ideas. The students use their group to bounce ideas around and they have confidence in speaking within the group, perhaps more so than the whole class.

We share the workload in a group, you get other ideas from your partner, their ideas rebound off your own, you can expand on your ideas.

Another question is posed: So what makes a good group?

The people who are focused on the tasks. We get to choose out partners with the teacher. He decides with us and we talk to other people who want to work with us. There's been some shifting around and I'm happier now in this group. It's best to work it out with the teacher, who gets into the group.

Another question is posed: So what makes a group that has trouble working together? The students respond describing the importance of making sure that all the students in a group have an opportunity to discuss their ideas and the work is portioned fairly. They describe the importance of negotiating who gets into the group with the teacher.

They don't get along with each other. They are always arguing or one of them does all the work and the others do nothing. You have to make sure that everyone gets a turn at something, share the load.

Two responses from another pair of students with the first question: Tell me about the opportunities you get explaining your ideas in a science lesson? These are excerpts from the full interview. It is interesting to note in this response that one student encounters difficulties in understanding what the teacher says. She complains of the teacher talking too fast but gets her friend to help her break the ideas down for her. This is an interesting social strategy that she initiates and has success with.

Most of my answers I write down from my head. I sometimes talk to my friends and watch what they are writing. We don't really get time to talk about the ideas, it's more doing stuff. Sometimes the teacher talks too fast and I don't understand. So I ask my friend about how to do it. She breaks it down for me.

You can work with your friend, but the teacher doesn't really like us talking. She's strict and likes it quiet. We talk, …. as long as we are quiet, she doesn't mind. We do the work together. We talk about work things mostly. When the teacher is busy doing something, you can go and get help from another friend.

These two students went on to say how they valued the importance of having ample time to talk about their ideas to their peers and how hearing ideas helps trigger new ideas. The strategy of the teacher giving out white boards to the students seems a positive method of stimulating discussion between classmates. Here is an excerpt taken from the interview.

We get heaps of time to talk about our ideas, Mr G has set up these small white boards, so we have time to write on them about our ideas. It's great, we explain our ideas to our friends and this makes us feel good. We think about their ideas and we sort of choose the best ideas. When we did the bio-dome each of us had different ideas, but we choose the best ones. We had to listen to the others.

Finally, an excerpt which describes the highlights and challenges of students working in a group. They describe how they deal with disagreements and how those disagreements can lead to bringing them closer - working more successfully as group.

> *It was awesome to build the eco-house, it was like a dream house.* (One of the students goes and gets the model of the house they have built together and returns with it). *The aim was….we were living in this house and we had to make our own food.* (The students launch into discussing the details on how the eco-house was made and the reasons about the choice of materials used). *We had to get our water, our energy, our foods. And how to feed the animals. We had our occasional fights, more like arguments,… disagreements.*
>
> *Because we fight, it brings us closer as a group. We bond a lot now. We can discuss stuff as a group.*
>
> *At the start of the topic we sectioned out the work we wanted to do. We went into this little room and we planned it all there. We each had a bit to do. Peter wanted to do the painting. Sarah wanted to do the walls and the rooms. Morgan wanted to be in-charge of the whole thing. It's kind of like a business. If we had to do this by ourselves, we would be stressing. We wouldn't have got it done. We spent ages discussing. We had to decide who got which things.*

The students describe the importance of planning; sharing the work out and making sure it is fairly proportioned. One particular feature of this interview was the sharing of control among all group members and the significance of being able to work things out together even if there was conflict in the process of negotiation. The aspect of having time to plan and to be able to take the opportunity to discuss ideas was vital for the success of the group to remain cohesive. Finally, the group discusses the concept of making crucial decisions about their learning, taking portions of responsibility in a task and having choice about what to do next were paramount to being confident and assured in their overall learning.

5.3 TEACHER INTERVIEWS

In summary, what the teachers most commonly talked about in the interviews was in relation to the highlights and challenges that they encountered in the project. There were three main themes that emerged from the teacher narratives. The first theme focuses on the nature of the collaboration, particularly the relationship interactions between students and between the teacher and the students. A collaborative environment is defined in this study as a shared space where students and teacher learn together through a process of interaction. In the interviews the teachers described the challenges of the shared learning space and the hitches of group work, particularly the difficulties of students selecting their own groups. They explain how it was important to teach the students how to work in groups, that successful group work involved sharing the work and taking on roles. The second theme to emerge from the interviews was the importance of relevance in the learning; this includes teachers describing how they carefully chose learning contexts and particularly the importance offering choice for the students. The third theme focuses on the teacher professional development. It includes descriptions from teachers of the challenges of the professional learning that occurred and also the merits of it.

The following teacher narratives have been selected to present information about these three consecutive themes.

5.3.1 Collaborative skills and relationship interactions

In one interview a teacher described the challenges of group work in her class and how there were some students that struggle to participate. She identified these students as not socially confident and having difficulties in discussing their ideas with their classmates. She commented on the students not having the confidence in speaking openly and not being able to use specific science terms required in the topic. She discussed the challenges of supporting these particular students to make contributions and to help them feel valued as a team player in the group. The teacher described how she provided literacy strategies such as specialised templates, which helped them engage in conversations. The students had greater confidence in using the correct scientific terms required in the activity, they could follow the templates

and keep up with the pace of the lesson. The literacy templates were writing frames and vocabulary lists. The following is a short excerpt from the interview.

> *One of the challenges of the group work is you always get some kids who don't participate in the work. They don't tend to take part, they just sit there and do nothing. How you get them to get involved –that's the hardest thing. Some kids will deliberately position themselves in a group that they know will do all the work and they will do nothing. I just don't know how to deal with this. ……there has to be a lot more scaffolding of the learning with students with poor literacy skills. Instead of going whollis bollis, I have to do the work in smaller chunks, building up their skills.*

Another teacher described the significance of taking an active role in moving around the room connecting with each group for most of the lesson. He talked about how collaboration must be modelled by himself and he believed that moving around the room with purpose was crucial in finding out what was happening in each group. At each group he could more intimately engage with conversation, sort out any concerns that had arisen and negotiate next steps for the students. He discussed how he makes an effort to engage with students who are struggling, making himself available for any queries but not in an obvious way. By going to each group helped him to be closer to the students and they also felt more comfortable in talking to him. He spoke about some students who would have been embarrassed if he had asked them how they were going in front of the whole class. The following is a short excerpt from the full interview.

> *…….it's also making sure that I walk around to each group. Just being there, so you are approachable. If someone is looking puzzled about something, it's good to go straight over and ask them if they need help. There are some very good leaders in this class that encourage the others. Some are very good at organizing the others and getting them to do things. But sometimes they can take over. This is where the teacher comes in and is crucial to sort out that sort of thing.*

Another teacher described how she found that student relationships were stronger if they could select their own groups. She believed offering her students choice in who they worked with, created an immediate positive atmosphere of trust in the classroom. She talked about how the students arrived in her class on the first day of school and how some already new each other from earlier schooling, so she used this to their advantage, students working together who knew each other. She described how it was important to find out more about these friendships, find out their interests and explore what topics they would like to learn about. This teacher sought help from deans and counsellors to assist her in determining what could be done to help the students who had learning difficulties and also with social problems outside of school. She spoke of how the students who had stayed the longest in their groups over the year had produced the best work. One of the features of this interview was the importance of teaching the students specific group skills. The teaching of these skills had to be explicit and modelled in class. The following are short excerpts taken from the full interview.

> *Some teachers have strong views that we (*teachers*) must put students in groups and that they must be mixed ability groups. As a result of this project- that is wrong. There's no way that proper cooperative learning can work if teachers select the groups and force students to work with students that they don't want to work with. Choosing their own groups is absolutely vital. They will naturally gravitate to kids who they get on with and have a similar curriculum level that they are working at. I believe whole heartedly the students should choose their own groups. However, we must spend time teaching them group skills. Making them aware of what is involved in a group project.*
>
> *.....of course some groups will reshuffle and then settle down through the year. Some of the social stuff that happens around groups is beyond what skills I have. We need to be encouraged to ask for help from the deans, counsellors and their tutor teachers to help us know what to do when things go wrong for these kids. It's really important we resolve social issues in the groups.*
>
> *However, it's the groups that have stayed together all year that have produced the most outstanding work. They've spent weekends together, sleeping over to spend time on their science projects. That's been fantastic. I've never had that*

before. The skills that they are picking up while they are doing this are very valuable.

5.3.2 Relevance

A teacher described the importance of giving choice to her students in their selection of topics. She talked about how the students became more focussed on the learning through the opportunities of having a choice. However, she also discussed how she prepared units of work that were at the correct level for the students. She rewrote the schemes of work that she had been given and redesigned them to fit better with the needs of her students. She described her students as keen but they struggled with writing and reading. She talked about the importance of having topics that they could relate to and that the students could be challenged but not so much that it would turn them off the learning. The following are short excerpts taken from the interview.

Choice has been a big thing this year, having a choice in what they can do really helps them get involved in science. It was also good to start with something like the Biodome because then they could learn about how to learn being together.

You have to make sure you obtain material that is at their level and it must be relevant to them. The literacy of the students is a real challenge. My guys are at level 2-3 of the curriculum and they have very poor skills in English. They struggle with interpreting the internet sites and reading a book. ……They get to a stage they just blindly copy the notes down. They don't know what they are writing about. But it was really important to do topics that they could relate over the year.

Another teacher described how her selection of topics was particularly important in making science enjoyable and engaging in a Year 9 single sex girls class. Having current events seemed to focus the students attention. She talked about the exposure of the media in the students' outside school lives, particularly from television, You-tube clips and catastrophic events such as the Japanese Tsunami. Using the media topics caught the girls' attention, hooking the students into the lessons. She designed

programmes using science activities that linked with the event. The following is a short excerpt from the interview.

> *It's been the relevance that has been the highlight this year. Having relevant topics like the Rugby World cup, the Japanese Tsunami, the Christchurch Earthquake, they were fabulous. My girls got excited about the topics and they would come to science excited.*

5.3.3 Teacher professional development

A teacher described the challenges and strengths of the professional development. She talked about how it helped her become more confident in creating new ways to engage her students. She welcomed the opportunity to discuss teaching practice with other teachers in a supportive group that met regularly through the year. For most of the year her classroom activities involved students working closely in teams of two to three students over a school term (approximately 10 weeks) and this sometimes led to social tensions between the students, which had to be sorted out before any activities could begin. She appreciated the students being enthusiastic and making more decisions in their learning. These excerpts came from the interview.

> *It has been exciting and given me freedom to experiment and dabble in experimental professional learning. The biggest highlight is seeing the kids excited. We've allowed students to have a lot more input into what they want to study and how they go about it.*

> *However, there have been negative vibes from the other teachers. I guess they were scared that my class would put pressure on the other classes to do fun stuff as well. If you do that then we all will have to do that. We will all look worse because you'll look better, there's a lot of that in this school. It's also a challenge to do something that is quite different. It's quite scary I guess doing something different. We like to have control over these poor souls. We're control freaks. And suddenly we put the ownership back over onto the students and we lose some of that control and that can be scary. But that's a good thing*

too. We need to be aware we don't know it all and when we let go of some of that control the kids will benefit from it.

The next question was asked about how we could further improve professional learning in the project and one teacher expressed the need for teachers to have the opportunity to observe other classes in different schools. It was important that teachers could see different practice going on and be exposed to the mixture of different pedagogy used in science lessons. This excerpt is taken form the interview.

We need more opportunities to go and observe other classes in other schools. Maybe you see the "Rolls Royce" model working in a class and then you see another class who are not up to speed yet. So you get a touch of realism as well as the ideal, so you can learn to become confident in trying to sort your own challenges out to.

Another teacher discussed the significance of employing a buddy system where teachers could be paired with other teachers from different curriculum areas. This could support further rich discussion in the professional development, help science teachers to link up with other curricula areas and observe the merits of different pedagogical practices that maybe going on. This following excerpt is taken from the interview.

….a buddy person where we can work with someone else from say another school or another curriculum area in our own school may help in professional learning. But the coming together each term was fabulous, that was really beneficial. I learnt heaps from the others in the project, just by talking.

5.4 STUDENT LEARNING DRAWINGS

In the following analysis of student drawings, it is the decisions and choices that the students make in the learning drawings that supplement further insight. The CLES scales were consistently considered, so comparison of drawings could be applied. They are described in the following table as five perceptions and written from a student perspective to help reveal patterns of ideas that may emerge from the

drawings. In the CLES actual questionnaire the main title written on the top of the script was "**What happens in my science classroom?**" However the question posed in the learning drawings request was "**What does learning look like in your science class?**" Consequently, there is a difference between the intent of both questions.

Ten drawings have been selected from the 117 that were received. These ten drawings have been chosen to keep the analysis in this chapter manageable but more importantly these particular drawings show contrasting perceptions of the CLES scales. For example some of the drawings depict students who appear passive in the classroom. However other drawings depict active, independent students, taking responsibility in the practical science tasks. In some drawings, the students have chosen to make illustrations clearly depicting students discussing their ideas with their peers while the teacher takes on a supportive role and there are some examples where the teacher is entirely absent in the drawing. A degree of contrast between co-constructive models of learning and transmission modes of teaching is observed in these drawings.

5.4.1 A selection of drawings and their interpretation

The selected drawings present details of teacher positioning in the class, the degree of student movement within the class, the student perspective of themselves as learners and the significance of how their peers influence their perception of learning. The selection of these drawings is drawn from a range of different classes over the years 2010 and 2011. This small selection is a snapshot of what was collected and analysed. Table 5.1 describes the five student perceptions that were used to interpret the learning drawings. The perception descriptions act as a framework to help interpret the visual images used in the learning drawings.

Table 5.1

CLES Scale *Perception Descriptions Used for Interpretative Analysis of the Student Learning Drawings.*

CLES Scale	Perception description
Personal Relevance	Students make sense of the world and how it is connected with their science experiences at school. Students make use of these everyday experiences as a meaningful context for building on science knowledge. Learning drawing depicts relevance of out-of- school experiences; nature of physical environment; nature of cultural relevance.
Uncertainty	Students have opportunities to experience that science has changed over time. That science is evolving and culturally determined. Learning drawing depicts science is evolving; science is culturally and socially determined; nature of physical environment.
Critical Voice	Students have the opportunity to express their opinions and to question. Learning drawing depicts: speech bubbles; inference of students having opportunity to speak; sense of student empowerment; students seen as comfortable in the class; students seen as cheerful in their learning.
Shared Control	Students are invited to share with the teacher the control of the learning environment. Students plan or help plan the lessons. Learning drawing depicts: degree of student and teacher movement; positions and size of images of students and teacher and student perspective of learning.
Student Negotiation	Students get the opportunity to discuss ideas with others and justify to other students their developing ideas. Learning drawing depicts positioning of images of students in relation with their peers; positioning and nature of images of tasks; size and nature of images of students; nature of physical environment and degree of student engagement.

The question posed to all students taking part was:

“What does learning look like in your science class?”

All the original drawings were completed on A4 size white paper.

Figure 5.1. Daryl's drawing of learning in science.

Daryl's drawing in Figure 5.1 is partly from the student's perspective, showing the teacher standing in front of the whiteboard. There is a sum written on the whiteboard and also the words *time* and *distance.* The teacher is facing towards the students and is about twice the size of the children sitting at their individual desks. A front desk is represented close to the whiteboard with an apple and an open laptop computer placed on it. The student with his/her hand up could be Daryl and it appears he is asking a question. Only four other students are represented in class, all are seated and face the teacher. It is not obvious that this room is a science classroom as there are no objects that could be related to a scientific context. There are windows with the sun and clouds drawn to indicate it is daytime. There is a spacious quality about the room which is unusual for the common crowded environment in a science laboratory. From this picture it appears that the students are attentive, passive and there is a sense of control that the teacher exerts in the classroom. There does not appear to be much opportunity for students to talk to one another with intimacy. Explanation of ideas and the sharing of immediate thoughts would be difficult as the desks are separated.

Figure 5.2. Sharon's drawing of learning in science.

In contrast to Daryl's drawing, Sharon (Figure 5.2) depicts greater student movement with some of the students standing at their desks. Here there are seven students depicted. There is a speech bubble drawn next to Sharon's head to portray thinking or speech. The students around her appear to be working in pairs and the teacher is in close proximity to them. Sharon has shown herself at the centre of the picture with her hands up and mouth open as if she is talking loudly or perhaps expressing an idea to the rest of the class. It looks as though Sharon is comfortable about speaking out in class. The teacher is depicted as taller and points at the whiteboard where the words *rules of science* are written. In this drawing, Sharon it appears that the students have the chance to talk with other students and have the opportunity to vocalize their thoughts. It also shows that there are students doing a mixture of different types of activity; some are shown as focused on their books at their desks and some in conversation with others.

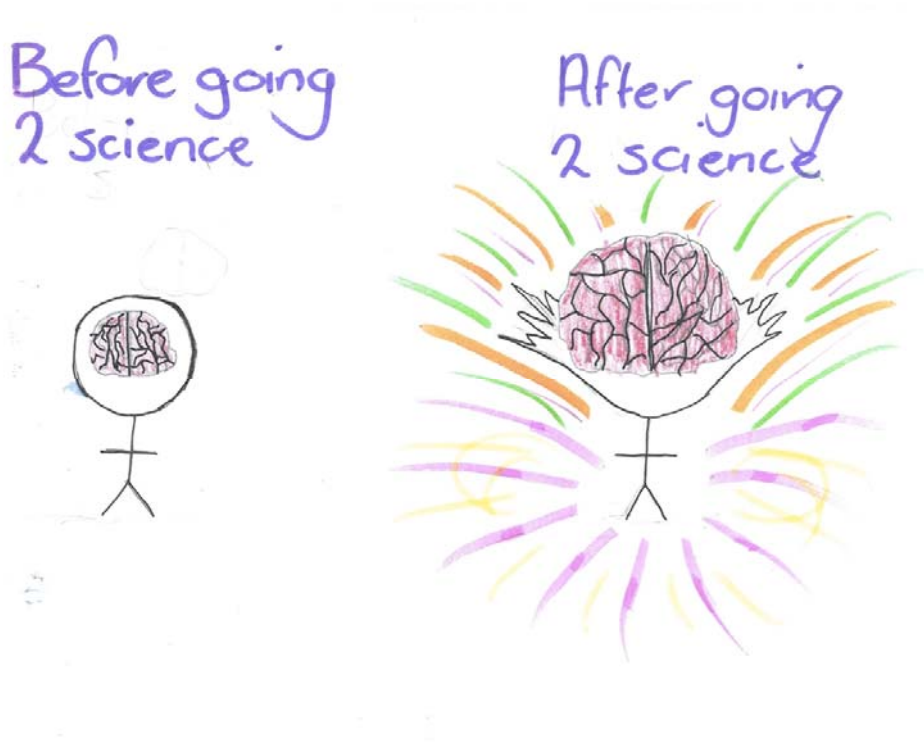

Figure 5.3. Rhiannon's drawing of learning.

In this dramatic presentation in Figure 5.3, Rhiannon has shown a transformation of herself before going to science and afterwards. She writes this clearly above the person in the picture. The drawing depicts the mind as being expanded and there is enhanced activity or stimulation of the brain after learning in science. Rhiannon has selected particular coloured felts and used them as quick strokes around the body, perhaps to show the change in her attitude after attending science. It depicts herself as the sole learner as there are neither other students nor a teacher represented in the picture. There is a sense that Rhiannon has the opportunity to learn and it seems that she is empowered by science learning.

Figure 5.4. Vance's drawing of learning in science.

In contrast to Rhiannon, Vance has neither shown students, nor himself nor a teacher in the room. The perspective is of the entire room including walls but no person present. The classroom appears to be bounded or to have an enclosed character. A significant theme that has emerged regarding some students is their relationship to the physical environment of the science classroom. Here, Vance illustrates this clearly and in detail: the types of equipment being used in the room, an equipment cupboard, the positioning of the tables and stools, the words on the whiteboard, aquariums at the side-bench, and posters on the walls. The room has been depicted as packed with science objects but also with a sense of order. This prominence of the physical environment in some of the drawings might possibly be due to the instruction of, *"What does learning look like in your science class?"* Nevertheless, Vance has selected these particular items and apparently for him this is what learning looks like. It indicates the importance of the equipment and the practical nature of performing a range of experimental procedures or tasks. Perhaps in Vance's perception of the immediate learning environment, there is no need for students or a teacher to support him in his learning. What may influence Vance in his learning could be the immediate activity and function of the equipment. He learns about

science when he performs practical experiments and he places an importance on equipment placed out ready for his experimentation.

Figure 5.5. Lesley's drawing of learning in science.

Lesley's drawing shows a greater number of students in her view of learning. Here the environment looks busy with some students' writing at their benches and some standing next to an experimental set up with puffs of gas rising. Some students are drawn with their mouths open portraying discussion. At the top left of the picture it looks as though the teacher is holding a candle in each hand or something that makes smoke. The teacher is not situated close to the students but is located at a distance, perhaps at the front of the room. She could be demonstrating something about the candles or the smoke coming from them. The whiteboard has "*copy these notes*" on it and includes the notes to be written. There is a sense that mixes of different modes of activities are taking place and the students have the chance to discuss ideas that arise. The students are operating together to find out what happens in the practical experiences and they are also voicing their ideas through dialogue. The scene shows signs that some students may dominate discussion, however there is an indication of sharing of ideas and students taking responsibility of their experiences.

Figure 5.6. Rachel's drawing of learning in science.

Rachel has drawn her teacher at the centre of the picture and four seated students of equal size that face towards the teacher. There are speech bubbles created for each of the students and they comment on their individual thoughts. Question marks are also drawn to perhaps symbolize an air of confusion amongst the students. There is some physical separation between the four students with not much interaction between them. The teacher is depicted as charismatic, smiling with her hands outstretched but in traditional mode - standing in front of the class and asking a question. There is also a speech bubble noting *"Hands up"*. A laptop is open on the front bench where the teacher is situated. Rachel has written the date on the whiteboard and some writing "*Volcanoe*" and "*Earth science"*.

Figure 5.7. Paul's drawing of learning in science.

In this scene, there are four students who are seated and performing tasks at their tables. There is a sense of business and engagement. A pair of girls on the left of the drawing is occupied with a laptop activity. Paul has sketched in detail the activities taking place with speech bubbles above the heads of each student noting, "*This is cool*" "*Yeah", "Ooooh", "Hmmm, friction increases the faster I go".* Music is being played on a stereo and there is an abundant set of notes titled "Practical *Instructions*" written on the whiteboard. However, the students are facing the opposite way to the whiteboard and the most amusing aspect is that the teacher has been drawn trapped in a cage which is hanging from the ceiling. He has labelled this "*teacher cage*" just under the drawing. Obviously, Paul has a sense of humour! Books and written material seem to be absent from the picture. However, the students are certainly using the opportunity to find out new ideas, access information, and overall the drawing depicts communication between the students. Paul has been quite frank in isolating the teacher from the students. In the picture, the roles of the students are portrayed as being active, collaborative and dominant. However, there is little interaction between students and teacher.

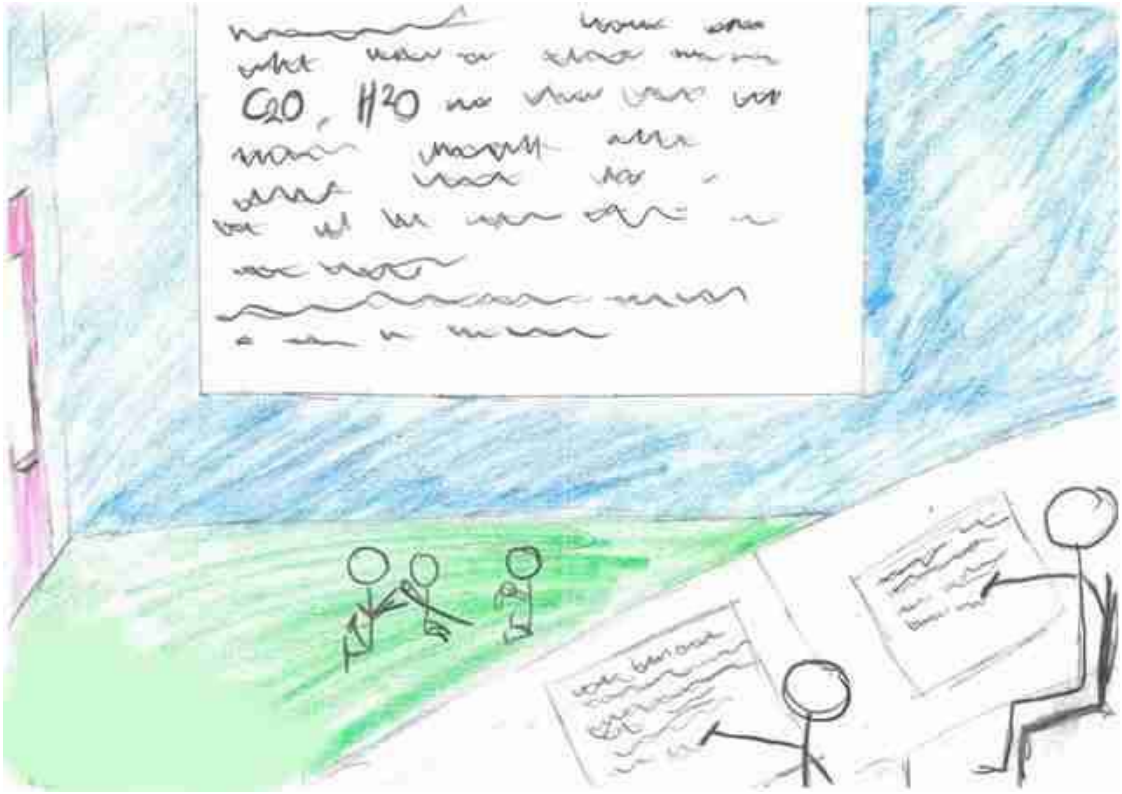

Figure 5.8. Jason's drawing of learning in science.

In this picture, Jason has drawn five students with two students seated at a lecture style table at the forefront of the drawing, they are depicted larger than the three further away. Both students sitting at the table have been shown with pens held in their hands and writing on paper. The pair have not been given faces - just circles, they appear passive and obliging with the forms of the stick figures used by Jason. The other three students sit further away, they appear distant and are working together in a group because of their close proximity, perhaps on a practical experience. The three students seem to be interactive facing one another. There is a large whiteboard displayed at the top of the picture with the symbols of chemical compounds, for example, water and writing. This writing is not in words but depicted as scribble and covers most of the whiteboard. There is no sign of the teacher in the room and there is a constricted feeling about the room with the drawing of walls and corners. There are neither speech bubbles nor facial features, such as eyes and mouths, drawn on the students.

Figure 5.9. Sarah's drawing of learning in science.

This scene is one of activity and movement. Sarah has chosen to draw eight students doing different activities with written comments next to each of the students. She uses the words, "*It looks like*…." where she describes what the learning is like. Two of the students are writing on the whiteboard which appears to be at the front of the room and they share each side of the board with a line drawn in the middle. The teacher is depicted as the same size as the students and she is separated from them, standing next to a desk near the whiteboard. The teacher is smiling with her hands behind her back or by her side. Three students sit at tables and appear to be writing while others are attending to practical tasks. There is a comment at the top left of the picture that says, "*It looks like copying down notes*" and a comment in the centre saying, "*It looks like doing revision quizzes*". There is another statement saying, "*It looks like taking a closer look at things*" at the bottom left of the drawing. The students appear to be in dominant roles in the classroom, actively engaged with a range of experiences. In contrast, the teacher is more passive in her role. There seems to be the opportunity for the students to converse with others. However, the written work appears to be individual and likely to be in books.

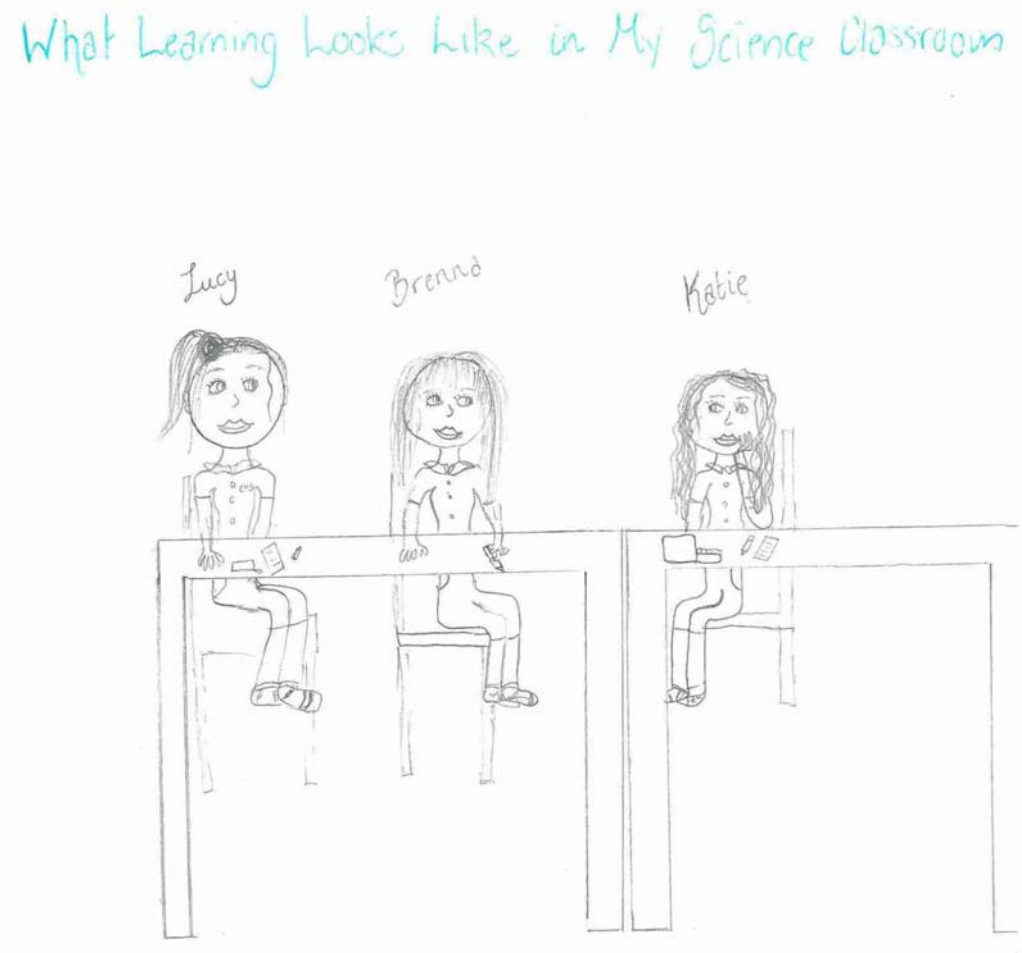

Figure 5.10. Lucy's drawing of learning in science.

Lucy has drawn herself and two other students. They are seated together facing out and appear to be on high stools which make them high up next to the bench. The figures have been drawn with much care and detail. The original drawing is on an A4 piece of paper with the figures making up the majority of the area. Lucy has placed emphasis on the fine points of the hair style and facial features of herself and her peers. There are neither scientific objects nor contexts used in the picture; hence it is not obvious to see that this is a science classroom. There is no sign of the teacher. There are pens and books, which have been drawn neatly in front of each pupil; however the students are not seen to be writing. The group appears to be passive and expectant with little interaction or social and not busy.

5.4.2 Overall findings from the learning drawings and the connection with student perceptions of their learning environment.

Ten learning drawings out of 117 have been presented in this section and they have been interpreted using an evaluation of choices that the students have made in the drawings. This included the presence and number of people; relative positioning of students and the teacher; the composition of size, shape of objects and people; repetitions of objects and people; written messages and clichés. The five CLES scale perception descriptions outlined in Table 5.1 were used in the analysis of all the drawings and the researcher made notes with respect to each of the scales for each drawing that was received. These selected drawings show contrasting perceptions of the CLES scales. The drawings helped identify what was happening in science lessons and the social positioning of the students and teacher in the classroom. The drawings helped to reveal the students' experience of science and gave further insight into how students perceive their learning. The following points are overall findings from the drawings.

- All drawings were unique (no drawing was identical to another).
- Most of the students portrayed classmates (114 out of 117). This suggested that most of the students perceive their learning in presence with other classmates.
- Most drawings (87 out of 117) had specific details of classmates and/or teacher (e.g., facial features, hairstyle, clothes)
- Some drawings (43 out of 117) had specific details indicating that science was taught there (e.g., Scientific apparatus, science terms on whiteboard)
- No student included the full compliment of classmates.
- Some students drew the crowded nature of the classroom (32 out of 117)
- Many drew speech bubbles and words connected with speech- this may depict a degree of critical voice (69 out of 117)
- Some drawings portrayed student discussion, movement in the classroom and/or there was a sense of social negotiation depicted (e.g., close proximity of students with specific actions detailed). (54 out of 117)

- Some drawings portrayed the student directly interacting with the teacher. (Speech bubbles and/or hand up and/or gestures depicted) (15 out of 117)
- Some drawings presented the teacher as the central figure in the room and in larger proportions compared to the size of the student images (16 out of 117)
- Most of the drawings depicted a teacher somewhere (83 out of 117)
- Some drawings portrayed students passive in the classroom with little interaction between students.
- Very few drawings depicted suggestions of out-of school experiences or images of world events/current media. This may suggest very few students sense their learning in science is relevant to out-of–school experiences or current events.
- Not all students included themselves- it was unclear whether the drawing included the artist.

5.5 CHAPTER SUMMARY

The results presented in this chapter show that qualitative data were collected to provide additional evidence of the nature of the learning taking place and to offer support in the interpretation of the CLES quantitative findings. The student voice in the form of audio interviews provided additional material to triangulate with the CLES results. The student interview questions were designed to closely associate with the nature of the five CLES scales. The CLES quantitative data were compared with student voice and this acted as a lever to unravel further details of each of the scales.

The student interviews covering the scale of Personal Relevance showed a rich source of details that clarified the need for teachers to place emphasis on relevant topics that can engage students in their learning. Students offered many examples of contexts and ideas that were connecting their science learning experiences with their personal lives out of school. However, some Māori students spoke candidly about the importance of Personal Relevance in their lessons, so that they could link their world outside of school to what was happening in their science lessons. Some Māori

students openly discussed their frustrations about how the science lessons did not engage them because the learning did not have any relevance in their lives. The interviews themselves were episodes where the researcher could capture a deeper sense of understanding of how students perceive their science learning in their school environs. The student voice has added details particularly about how students work in groups and how they negotiate their learning with other members of the class. Furthermore, the interviews provided interesting details about how the students sensed their input into collaborative activities and shared projects.

The student learning drawings added further insight into revealing the perceptions of the students. The drawings depicted details of teacher positioning in the class, the degree of student movement within the class, the student perspective of themselves as learners in a class and the significance of how their peers influence their perception of learning in a class. The perceptions of the CLES scales supported the analysis of the drawings.

CHAPTER 6

INTERPRETATION AND DISCUSSION

6.1 INTRODUCTION

This chapter presents an interpretation of the quantitative and qualitative findings and provides an overall discussion that endeavours to link them together.

Section two provides overall interpretations of the variations from the CLES results. There are short discussions on variations with regard to changing perceptions over the two years 2009, 2010 and taking into account student gender and ethnicity. In addition to this, there are some statistical interpretations of selected individual items of the survey that identify the distribution of the relative percentages of the students. The discussion on the percentage distribution of these individual items offers additional interpretation in considering the overall CLES patterns.

In section three, comparisons are made between the CLES data and the qualitative voice; this includes the student interviews and the student learning drawings. This section places emphasis on the connections between the CLES and the qualitative voice.

The fourth section discusses themes that have emerged from the overall findings and provides an opportunity to initiate a response to the research questions.

6.2 INTERPRETATION OF THE VARIATIONS OF THE CLES RESULTS

This section provides a further interpretation on the variations of the CLES results with regard to the variations of the students' perceptions in both years of the study

and with particular attention to gender and ethnicity. There are some quantitative interpretations of selected individual items of the survey that identify the distribution of the relative percentages of the students. There are figures of histograms that illustrate the distribution of the student responses; these help provide additional consideration to particular items of the CLES and offer greater depth of understanding of the overall CLES scale mean values.

6.2.1 Further interpretation of the CLES results

The first impression of the overall summaries of the CLES results from both years 2009 and 2010 is that they are noticeably similar. Each of the scales indicate similar values with the Shared Control scale standing out as the lowest actual mean value. This indicates that the CLES was replicable given the same questionnaires were given to other new participants. In the year 2010, the sample size only slightly increased from 332 students in 2009 to 364 students. This indicates that the results came from similar sized samples. One of the aims of repeating the CLES in the year 2010 was to investigate whether there were similarities in the results and to perhaps consider if there had been some slight changes to the learning environment. There was awareness that the majority of the teachers in the research project had remained the same in both years 2009 and 2010; and also that the schools remained the same; however, the majority of the participants were newly acquainted with the teachers at the start of each of the years. As mentioned in Chapter 4, the results from both years showed consistent reliabilities and both demonstrate the effective use of the CLES in a New Zealand setting. Nevertheless, the findings show that the new students at the beginning of the year 2010 had very similar perceptions about their science learning as did the students at the beginning of the year 2009. One would think that the teachers (who remained unchanged over the course of the study) would have had more of an influence on the results of the initial 2010 actual CLES, particularly when they had been involved in a significant professional learning program over the previous 2009 year.

What was characteristic of the CLES findings was the rise of the actual mean values across most (but not all) scales over the course of a year and this was encouraging for the teachers. The post actual means were higher in value from the earlier actual

means and these indicated definite changes to students' perceptions in their science learning. One good example of this was with respect to the Personal Relevance scale: the actual mean value in the year 2009 was 3.12, the preferred mean value was 3.24 and this rose to a post actual mean value of 3.40. A similar shift took place in the year 2010. Both shifts were statistically significant. These encouraging changes from actual student perception towards their preferred perception (sometimes greater than their original preference) showed that the learning environment had the ability to change. The results demonstrated that the learning environment was not static and the participants' perceptions and attitudes to their science learning over the course of the year did vary. Furthermore, the results show an interesting pattern about the students' perceptions of their learning environment and this was noticed over the course of the year. It was the nature of the learning environment that had the ability to change well beyond what is preferred or what is seen to be ideal earlier in the year. The post actual learning environment results collected later in the year were greater than their earlier preferred mean values. This particular shift stood out in the Personal Relevance and Uncertainty scales in the year 2009.

The initial actual means across all scales may have been very similar in both years but what was obvious was there can be significant change to the immediate learning environment over a year with these higher post actual mean scores in mind. The other aspect to also bear in mind was that the values show averages across all classes. There were individual students and consequently individual classes with actual CLES means that dramatically shifted to higher values and this was pleasing to see.

6.2.2 Interpretation of the CLES findings with regard to student gender

There was no statistically significant difference in the comparison of boys' and girls' perceptions of their science learning across the classes except for the Student Negotiation scale, refer to Tables 4.9 and 4.10. Nevertheless, as well as the Student Negotiation scale there were other scales that seemed to stand out and are worth mentioning in a little more detail. In considering the CLES data differently, with particular attention to the individual items of the CLES rather than the mean values of the scales, the data were analysed using Fathom statistical software. There were 25 items in the survey and the Fathom software had the ability to analyse individual

items of the survey and provide valuable additional insight into the CLES scales. For example, as mentioned before, one of the scales that particularly stood out was Shared Control. This scale is described as concerned with students being invited to share with the teacher control of the learning environment. The results of this scale presented earlier in Chapter 4 show that it is substantially lower than any other scale in the CLES. The first item in the student survey of the Shared Control scale is item 16 (which is described as "I help the teacher to plan what I'm going to learn") and with additional analysis of this item in the actual form results reveal 39% of all the participants in the year 2009 signalled that they almost never did this with their science teacher (see Figure 6.1). Looking further at the results of this particular item but with gender in mind, the girls showed a greater proportion who held this view than was the situation with the boys. This gender comparison is presented in Figure 6.1 with the distribution illustrated, the girls' results are shown in red and the boys' results grey. In the year 2010 this proportion of girls remained remarkably similar to the year 2009 results.

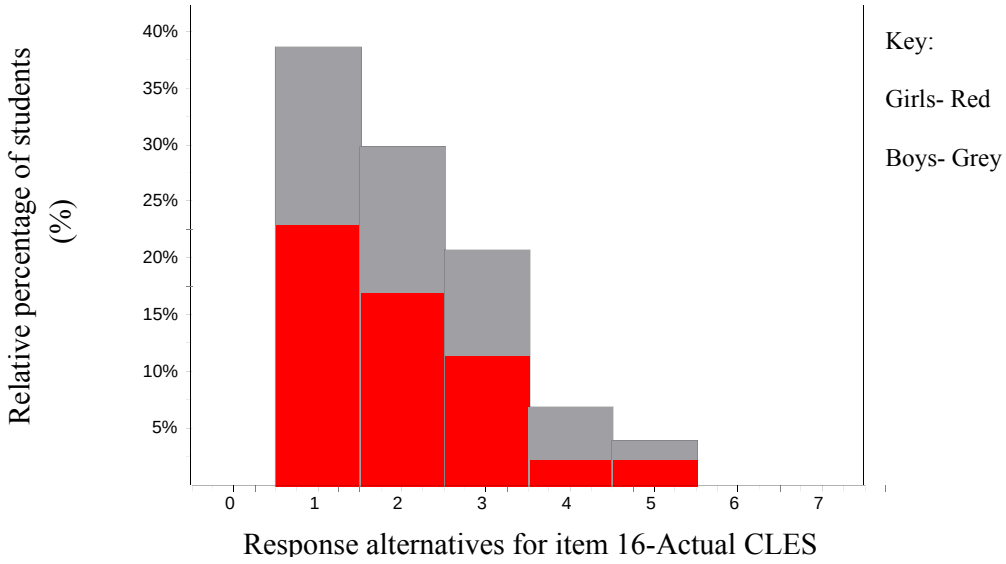

Figure 6.1. Distribution of the relative percentages of students indicating the response alternatives in the item number 16 in the Actual CLES.

Figure 6.1 illustrates the distribution of the item 16 results of the CLES across the five alternative responses that can be selected on the questionnaire script. This item states "I help the teacher to plan what I'm going to learn". The response alternatives

are: 1-Almost Never, 2-Seldom, 3-Sometimes, 4-Often, 5- Almost Always. The histogram shows the relative percentages of the cohort in the year 2009, the red colour highlights the relative percentage of girls and the grey colour highlights the relative percentage of boys. The figure shows the disproportionate percentages of girls having lower scores for their perception in planning with the teacher their learning.

There is another CLES item that appears to have some contrasting views between boys and girls with respect to the Personal Relevance scale. There is an item titled: "My new learning starts with problems about the world outside of school" in the actual CLES questionnaire, which is grouped under the Personal Relevance scale.

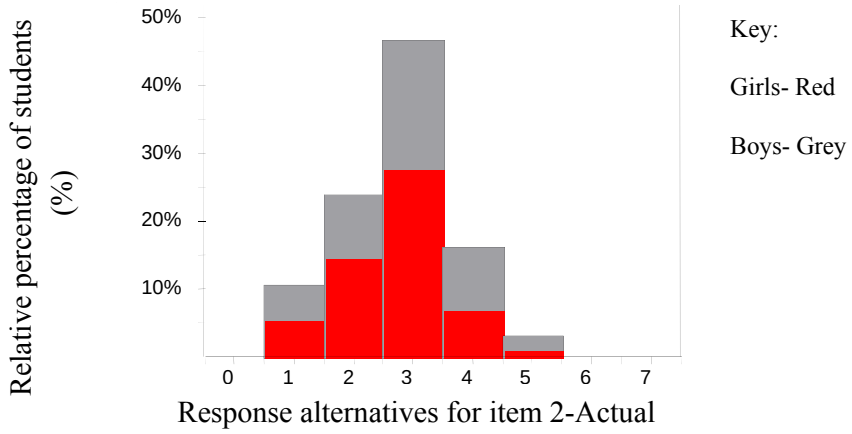

Figure 6.2. Distribution of the relative percentages of students with comparisons in gender, indicating the response alternatives in item number 2 in Actual CLES.

Figure 6.2 illustrates the distribution of the item 2 results of the CLES across the five alternative responses that can be selected on the questionnaire script. The response alternatives are: 1-Almost Never, 2-Seldom, 3-Sometimes, 4-Often, 5-Almost Always. Figure 6.2 reveals that 71% of the sample has chosen 1-Almost Never, 2-Seldom or 3-Sometimes. In terms of the girls' perceptions to the Personal Relevance scale, the results show disproportionate lower scores than the boys.

Conversley, the Critical Voice scale mean results with respect to gender differences present higher values for girls than for boys in the actual results in both years. There is one particular item in the CLES Actual questionnaire which states: “Is it ok to express an opinion in class?”(see Figure 6.3) and the girls indicate much higher proportions of the values 3 to 5 in this particular item than the boys. The Actual mean score for the girls was 3.28 and the Actual mean score for the boys was 3.09. These values both jumped up to preferred values of 3.48 and 3.46, respectively. The post actual mean values were 3.52 for the girls and 3.43 for the boys.

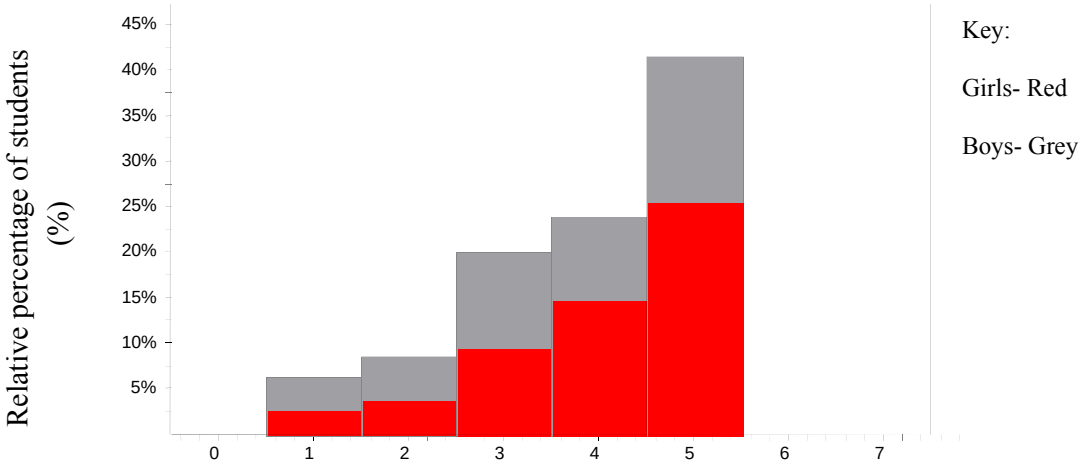

*Figure 6.*3. Distribution comparing the relative percentages of students indicating the response alternatives in the item number 15 in the Actual CLES.

Finally, there is one scale that seems to stand out particularly for girls and it is Student Negotiation and it is the only scale that was statistically significantly different. The mean values of 3.56 for the girls and 3.28 for the boys in the year 2009 show greater significance than any other scale. The mean values of 3.59 for the girls and 3.19 for the boys in the year 2010 presented similar mean differences but with no statistical significance. If particular attention is given to item 21 of the actual CLES which is described as “I get the chance to talk to other students”. The distribution of the results is illustrated in Figure 6.4 and shows relatively higher percentages of girls favouring this Student Negotiation item over the boys.

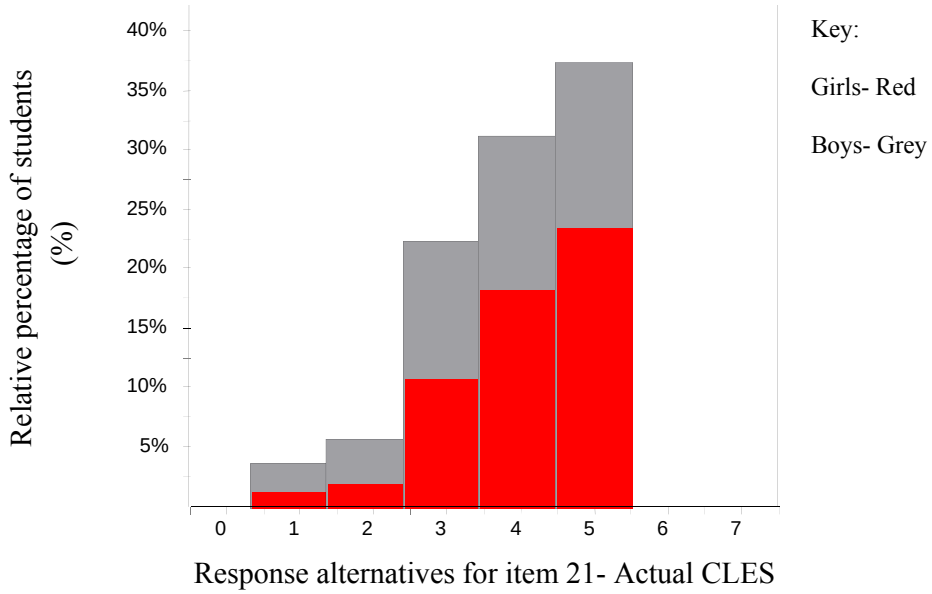

Figure 6.4. Distribution comparing the relative percentages of students indicating the response alternatives in the item number 21 in the Actual questionnaire.

The opportunity to explain ideas to other students also shows a disproportionately higher perception from the girls than the boys. Conversely, the scale of Personal Relevance is higher for the boys than the girls and it seems that the boys have a perception that their learning about the world outside of school is more favourable than do the girls. However, overall these variations with respect to gender difference are less significant than the other variations in this study.

6.2.3 Interpretation of the CLES findings with regard to ethnicity

The CLES results were analysed as a separate statistical assessment to compare ethnic differences across all the scales, refer to Tables 4.11 and 4.12. The students in the classes fell into three main ethnic groups: NZ European, NZ Māori and Pacific. Analysis of the results indicates that higher percentages of NZ European students view their learning environment more favourably than do NZ Māori students in both years. For Pacific students, most of the results showed further lower scores across the scales and the Pacific students had significantly lower scores than NZ Māori students. The only exception to this trend was the Shared Control scale, where NZ

Māori students had a slightly higher Actual mean; this was in the year 2009 (see Figures 4.3 and 4.4).

Further analysis of the results regarding the NZ Māori students indicate that they have a significant presence in the classes with 31% of all the students that took part in the CLES being NZ Māori students. The CLES results reveal clearly NZ European students sense a more constructivist classroom climate than do NZ Māori students. This is shown by the higher scores of Personal Relevance, Uncertainty, Critical Voice and Student Negotiation for NZ European students.

On closer examination of the Personal Relevance scale, NZ Māori has an actual mean value of 2.92 in contrast to the NZ European actual mean value of 3.22 in year 2009. NZ Māori students readily showed that they did not sense as much relevance in their science lessons as NZ European students. Further evidence of this was observed in the year 2010 with Actual mean values of 3.02 for NZ Māori and 3.21 for NZ European for Personal Relevance. Bearing in mind this particular scale of Personal Relevance, attention is given to item 2 of the Actual CLES which is described as "My new learning starts with problems about the world outside of school". The distribution of the results is illustrated in Figure 6.5 which highlights the relative percentages of NZ European and NZ Māori.

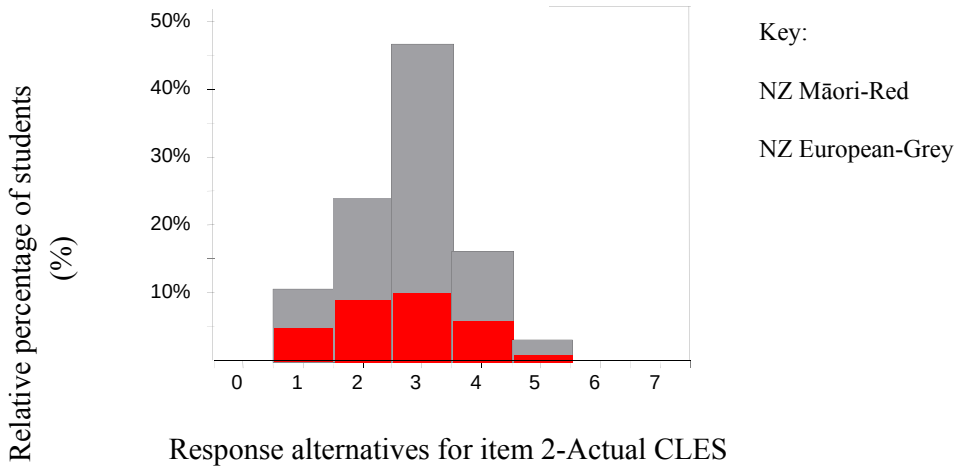

Figure 6.5. Distribution comparing the relative percentages (with comparisons to ethnicity) of students indicating the response alternatives in the item number 2 in the Actual questionnaire.

On closer examination of the Critical Voice scale, NZ Māori students have a mean Actual value of 3.14, which is reasonably low compared with the other two ethnic groups. For a race that are accustomed to take up challenges such as the traditional Haka one could suggest that expressing opinion in class and the idea of challenging the way they are taught in class, would perhaps be more comfortable for them than NZ European students. However, this is not what is revealed in the CLES results.

6.3 COMPARISONS BETWEEN THE CLES FINDINGS AND THE QUALITATIVE VOICE

There are some trends that have been described earlier from the CLES quantitative results with regard to the qualitative student perceptions of their classroom science experiences. This section endeavours to make comparisons using both sets of data and provide explanations. There are two points that introduce the comparisons.

Significance of the Shared Control scale

The first point, and perhaps the most striking finding as it stands out from the other student perceptions in the CLES, is the low mean values for the Shared Control scale. The actual mean for Shared Control value was the lowest of all the scales and measured 2.19 out of 5.00 in the year 2010. It had the highest statistical significance in the differences between actual and preferred for both years 2009 and 2010, refer to Tables 4.5 and 4.6. Much of the recent literature on socio-constructivism, as Watkins et al. (2007) point out, advocates the importance of students to have the opportunity to help the teacher plan what is to be learned.

The Te Kotahitanga professional development initiative that has been implemented in some secondary schools emphasised this. The nature of sharing power in the classroom between students is also described in the recently implemented New Zealand Curriculum 2007, which explains the need for students to participate and contribute, particularly with reference to 21st Century learning needs. "Participation and Contribution" is one of the five Key Competencies described in the document on page 13 and it highlights the value for students to be active not just in the classroom space but also at the community level where the student makes active connections with a range of people (Ministry of Education, 2007).

Vygotsky (1978) also defines the significance of the ability to gain knowledge as socially determined and he describes learning as inextricably connected with social presence. Teachers can have good intentions to help guide the learners in a class; however at times a degree of learner autonomy can take second place. Developing shared control within the learning environment and the act of students being invited to make decisions about the next learning tasks can be challenging for science teachers. Bishop and Berryman (2006) consider co-constructing learning tasks with students an important classroom strategy to help students be in the driving seat of the learning. They suggest offering opportunities for students to share the decisions in what happens next, with regard to their learning, can make substantial shifts in attitude.

The learning drawings provided visual descriptions of what learning looked like from the eyes and thoughts of the students. Some drawings portrayed the student directly interacting with the teacher (15 out of 117). Therefore, some drawings could have suggested there was a degree of co-construction of planning between teacher and student. More drawings depicted student movement in the classroom with images of students having choice in the science lessons with the teacher present. Some drawings portrayed student discussion, movement in the classroom and/or there was a sense of social negotiation depicted (54 out of 117) however, this may have not been a sharing of control with the teacher rather a negotiation between student to student. Nevertheless, there was little evidence from the pictures of the act of planning the learning between the teacher and student or little presentation of the students operating together with the teacher in working towards a shared goal. Sixteen drawings presented the teacher as the central figure in the room and in larger proportion compared to the size of the student images. There were some drawings that depicted students taking a passive role such as sitting at desks facing the teacher who was shown to be the decision maker in lesson objectives. These drawings showed the students as seated and working individually with the teacher taking a dominant role in the science lessons. This offers some additional evidence to support the low CLES findings of the Shared Control scale.

Personal relevance

The second point is that the students who spoke in the audio-interviews talked candidly about the importance of the ideas of personal relevance and how relevant learning contexts were particularly important to connect themselves as learners with their classroom experiences. The results of the Personal Relevance scale have revealed that NZ Māori and Pacific students were disproportionately represented with lower mean values compared with NZ European students. Personal Relevance was statistically significant in year 2009 but not in 2010. The use of relevant and everyday contexts for students involving the world outside of school has been a significant focus in the professional learning sessions with the teachers. From the findings of the early student interviews in the year 2009, the project acknowledged the need for students to be able to learn about recent world affairs and in particular the need to consider issues that were immediate in their personal lives rather than

from the past. The themes from the interviews presented Māori students as largely aware of their family associations and how these were important to them outside of school. Many of the Māori students spoke candidly about the importance of their relationships with their parents and these were inextricably linked with their own personal interests. In particular, it was the sporting pursuits and cultural occasions that were contexts discussed as fundamental for these students in making connection between what was central in their lives to what was happening in lessons at school.

6.3.1 Comparisons of the CLES findings and the learning drawings

When the students were asked to draw what learning looks like in their science lessons, they had to make choices about what to draw in their pictures. They made choices about people they would omit or include. The first point here is that most of the students (114 out of 117 drawings) portrayed classmates in their drawings. This suggests the significance of the students drawing the social world around them as learners and perhaps the suggestion of their peers contributing to discussions about the learning taking place in the science activity. No student displayed the full complement of classmates in their drawing.

The Student Negotiation scale described in the CLES as the opportunity to discuss ideas with others and justify to other students their developing ideas is particularly linked to this emerging pattern in the drawings. The preference for Student Negotiation has the highest mean value of 3.74 out of 5.00 compared to all other scales and this suggests how highly students rate the importance of being able to communicate with others. There is also statistical significance of the Student Negotiation scale between actual and preferred in 2009. This shows the importance that the students place on the interactions and relationships with their peers.

A general impression of most of the drawings is how the students have put such care and thought into the details of the people in the science lessons. Most drawings (87 out of 117) had specific details of classmates and/or teacher. Very quickly we sense the magnitude of the influence of peers and friends in the immediate learning world of the student. Many of the drawings show speech bubbles, which describe the particular science activity taking place or comment on student attitudes to science.

The second feature of the learning drawings is some of the drawings show the individual student as central to the learning and other drawings represent the student as being merely part of the scene. There is no overwhelming evidence from the drawings to suggest there is more of one or the other. However, most of the drawings represent the degree of the individual or group of individuals being able to talk in class or to think in class about the science lesson. Many of the drawings represent some form of speech or thought using speech bubbles or gestures situated next to the image of the individual. Many drew speech bubbles and words connected with speech- this may depict a degree of critical voice (69 out of 117). There was only one drawing that had neither people nor the individual in the picture, out of the 117 drawings. Critical Voice is described as learning to speak out and express an opinion in class. The Critical Voice scale has a preferred mean value of 3.47 and 3.58 in the years 2009 and 2010, respectively. This again is evidence of the importance that students place on the opportunity to be involved in the lessons and have a say in what is going on. Student interaction, discussion and freedom to express opinion are suggested to be important to the students.

We must now consider how students perceive the role of the teacher. The learning drawings reveal some interesting ideas. The students have made a choice about whether they will draw or not draw their teacher in the picture. The interaction between themselves as learners and their teacher is dramatically portrayed in some of the pictures. The size and position of the teacher in the drawings are significant as to how the individuals sense themselves as independent or dependent of the teacher for their learning. What is somewhat unsurprising is that most of the drawings (83 out of 117) had an image of the teacher somewhere in the picture. This could suggest the dominance of the teacher in the physical space and/or perhaps the learning space of the individual. In some of the drawings, the teacher is positioned at the front of the class, close to the whiteboard and in some of the drawings the teacher is either larger or taller in size compared with the relative size and height of the students. Some drawings presented the teacher as the central figure in the room and in larger proportions compared to the size of the student images (16 out of 117).

The CLES results show preference for greater student control in the classroom with preferred mean values of 3.08 and 3.09 out of 5.00 in the years 2009 and 2010,

respectively. The actual mean values were 2.23 and 2.19 out of 5.00 in the years 2009 and 2010. There is also the highest statistical significance in the Shared Control scale between actual and preferred. This shows a shift in student perception between what happens in class and what they would prefer to happen. It is difficult to identify the act of planning or co-construction between the learner and the teacher in the drawings; however there is an overall sense in most pictures that the classroom climate is an interaction between the individuals and the teacher. Many students portray activity and the conversations around the activity with regard to teacher decisions rather than student decisions.

In some of the drawings, there are a choice of activities and tasks where the students are represented as moving from one to the other. However, this does not indicate the opportunity that the students were given to help the teacher decide on those activities. As discussed earlier in this chapter, a large proportion of students (39% of the sample) chose the response of "Almost Never" in the CLES item 16 under the Shared Control scale, when they were asked about the ability to plan what they are going to learn with the teacher. In conclusion, many of the drawings do not depict an environment where there is a strong sense of co-construction occurring; however there is interaction between the teacher and the individual.

6.3.2 Comparisons with the CLES findings and the student interviews

The interviews were conducted with student groupings of friends to help with making sure that they were as comfortable as possible in responding to the questions. A feature highlighted in the student interviews is with regard to the student perception of learning about the world outside of school. Many of the students, of all ethnicities interviewed, spoke at length about how important it was for the science lessons to be relevant to what was happening outside of school. Many spoke of the wide gap between their personal reflections, interests at home or family activities and the reality of the classroom world. Some students felt frustrated, they held strong and passionate views on certain topics but they sensed these were not valued in science lessons by the teacher. A number of students spoke of boredom in the lessons and not being able to relate the content of the topics to their personal lives. There

were several identified NZ Māori students who spoke of this mismatch of their personal interests and the lesson activities.

The CLES results for the Personal Relevance scale have been shown with particular pertinence to the NZ Māori and Pasifika learners, indicating lower mean values than for NZ European students. What was promising to hear was that some of the student narratives confirmed positive student engagement with the use of recent current world events in the science lessons. Some students spoke enthusiastically about their teachers who had introduced topics that were current or in the news headlines. Some students spoke favourably about their teachers who had given them the opportunity to take an active part in keeping up with the latest news in the lessons. Examples of items that were referred to were the Japanese Tsunami and the Rugby World Cup that took place in New Zealand in 2011.

6.4 EMERGING THEMES

This section provides a discussion around three themes using the earlier discussions on the comparisons of the CLES and the qualitative voice. The first theme concerns the findings about the practice of shared control in the classrooms. Sharing control with students can be demanding for teachers, particularly when students have high literacy or other special needs. There is a tension for teachers between having control over decisions about what they perceive to be important learning objectives and offering the opportunity for the students to have a say about what they would like to learn. Both the CLES data and the qualitative voice suggest that the students wish to have greater opportunity to be present and active in the decision making about the activities and learning that could take place. The balance of power in the classroom between the teacher and the student is dynamic and as we have realized in the analysis of the learning drawings and interviews, this awareness of the importance of shared control is what has been suggested from the students in this study.

The second theme is the opportunity in the classroom to make connections to previous learning, where teachers build on what the students know and are experiencing outside of the classroom. In this research, it was particularly noted when the teachers provided global issues in their lessons the students responded

favourably in the CLES post data with respect to the Personal Relevance scale. The teacher interviews identified what contexts were relevant and whether the students had choice of these topics. However, it is important to keep in mind that the students responded to a wide range of personal interests in the student interviews.

The third theme is the significance of the students themselves as learners. It is the identity of the student, where they project themselves socially and emotionally in association with their peers, that can be unnoticed in a busy classroom. The data from the CLES scales of Critical Voice and Student Negotiation provided evidence to help describe the degree of socio-learning in the science lessons. This focused awareness and sense of understanding of the socio-learner helped to inform the teachers in the professional development sessions.

6.4.1 Facilitating shared control in science lessons

The New Zealand Curriculum specifically addresses the need for the adoption of effective teaching practices that pay close attention to the facilitation of shared activities and conversations among students. However, what sometimes can be noticed in secondary science classrooms there is interaction among the students but perhaps little focus on the importance of the interaction between teacher and student. Planning, designing and managing learning activities with students pose immediate challenges to teachers. In particular, secondary science teachers can have strong content knowledge in their area of expertise but may require support in using appropriate pedagogical techniques to enhance student centred learning. Recently in New Zealand, there has been school-wide teacher professional learning with an emphasis on cooperative learning strategies and shared learning among students but perhaps not an emphasis on the significance of teacher-student interactions. The student interviews, and in particular the Shared Control actual and preferred means, reveal how much the students wanted to have more autonomy over lesson planning and co-construction of their learning. The quantitative results report that the greatest mean differences between the actual and preferred learning environments was of the Shared Control scale. There are t-values of 12.42 and 13.88 with respect to the years 2009 and 2010. These high values signal shifts in student perception from actual and preferred differences in the Shared Control scale. Furthermore, many of the students

spoke in the interviews about their engagement with their teacher and the importance of the conversations between the teacher and themselves. Some of the students described this as a factor in their success in science as a subject at school. The students also spoke about building their science knowledge in association with their teacher and that their teacher was influential in helping them identify the next steps in their learning.

What was recognized early on using the CLES, with the low scores of Shared Control in mind, was the need for the teachers to plan the science activities with the students. What was noticed from the narratives was that the students spoke of how the shared interactions between them helped them to feel empowered in their learning. In conjunction with the increased CLES Shared Control post actual scores, the interviews reported positive student responses about the teachers who gave them the opportunity through the week to decide on what activities were best for them to learn about. The act of negotiation between the teacher and the students with regard to how much time they could spend on activities was also noted as important to the students in the interviews.

6.4.2 Making connections to learning about the world and personal experience - Ethnicity differences

With respect to the Personal Relevance scale; the ANOVA testing values in the CLES reported statistical significance in differences between Māori/Pacific and NZ European students in the year 2009. The results report that NZ European students perceive "Learning about the world" more favourably than both Māori and Pacific students. There was one statistical difference in the actual, preferred and post actual forms of Personal Relevance. The findings from the student interviews also indicated that when the teachers deliberately built on what the students already knew and helped make use of everyday experiences, the student narratives were positive about their science lessons. In some of the interviews involving Māori students, they responded positively to lessons where learning was about recent world events and made connections between what was happening at home and what was happening in science.

As discussed earlier, the professional learning sessions with the teachers involved developing resources that would actively involve students in taking an active role in learning about immediate global events. The scientific ideas and skills were directly linked with the contexts used in the resources. This study encouraged the teachers to pose scenarios and/or questions that would provoke discussion involving personal experience. It was also important to realise that the students have a wide range of personal interests and identities, not just a whole class scenario. There was a need to take account of different interests, cultural perspectives and individual pursuits so that learning in science was connected to the student's everyday life, not something that was separate from real life situations or in the past.

6.4.3 Social presence in the science classroom

The students' perception of the opportunity to discuss ideas with others and the extent to which they could express their opinions in class seemed to be increasingly apparent in this study. Student interaction in the science classroom surfaced as a factor in further understanding the immediate collaborative environment. There are statistically significant differences between the actual and preferred CLES values for the scales Critical Voice and Student Negotiation with reasonably high t-values of 4.34 and 5.5, respectively. The Student Negotiation scale has the highest reported mean values over all forms in both years 2009 and 2010 compared with the other four scales. This emphasizes the importance that students place on explaining and justifying their ideas with their peers. Both the Student Negotiation and Critical Voice scales stand out with female students perceiving the learning environment as more favourable than did the male students. The greatest significant difference is between the girls and the boys with respect to the Student Negotiation scale.

In the student interviews, the ideas discussed around "Learning to communicate" were varied. Many spoke of how it was important to negotiate the role of each student in a group and how it was easy to stay focused on the learning if they could work with classmates they already knew. Working with students whom they selected rather than the teacher selected was emphasized in helping them feel comfortable with their learning. Some of the interviews drew attention to how important it was for the students to discuss their ideas and debate decisions about what was going on

and what was about to go on in the science activity. Some students indicated that there was a tendency for teachers to place emphasis on science content and miss the opportunity to encourage student discourse in the lessons.

The learning drawings reported the importance of the social world of the learner with the majority of drawings identifying classmates in the pictures. Many of the drawings depicted peer communication and student interaction rather than specific scientific learning. Many depicted the intimacy between the students in groupings in the classroom, all 117 drawings suggested a unique and varied learning world by each student (No picture was identical).

6.5 CHAPTER SUMMARY

This chapter draws together a range of ideas and interpretations that have emerged from the research findings and it has endeavoured to construct some emerging themes with respect to the statistical significance of the CLES findings and the qualitative student voice. Both sources of data report snapshots of the student perceptions of life in a secondary science classroom in New Zealand and collectively they have constructed some significant revelations. The learning drawings have helped to add colour to the variations of the CLES findings with particular relevance to the social world of students and the significance of teacher-student positioning in classrooms. The interviews have added further interpretation and actual examples of how important personal relevance is to students so that they can be engaged and empowered with contexts that they can connect with. There are also the findings of the differences in perception between ethnic groups and how, in particular, Māori and Pacific students are signalling that they are disproportionately being represented in having lower perceptions of the learning environment with reference to personal relevance in science lessons. The low mean values of the Shared Control scale in the CLES across both years 2009 and 2010 and the statistical significance between the Actual and Preferred perceptions indicate the willingness of the students to want to co-construct learning activities with their teacher. The social interaction in the classrooms seemed to be an overwhelming theme that has emerged from the Student Negotiation and Critical Voice CLES findings. As well as this the practices of student talk and peer interactions were shown to be important to the majority of the

students in both the drawings and in the interviews. The statistical significance of the Student Negotiation and Critical Voice perceptions have indicated further advocacy for students to express their views and discuss their ideas with peers. The next chapter concludes this thesis and presents a summary which responds to the research questions.

CHAPTER 7

CONCLUSION

7.1 INTRODUCTION

This chapter presents a conclusion to the study and the first section provides an overview of the thesis commenting on the preceding chapters. The second section provides answers to the research questions. The third section develops a response to each of the objectives. The fourth section discusses the significance of the study with respect to the field of learning environment research. The fifth section discusses the limitations of the study. The sixth section offers suggestions for further research and the seventh provides a final comment.

7.2 OVERVIEW OF THESIS

This thesis reports on the immediate perceptions of Year 9 and 10 students in secondary science classes in New Zealand in the years 2009 to 2011. It brings attention to what is happening in science lessons with regard to student social presence, the degree of personal relevance being used and the nature of the learning going on in the immediate learning environment. The focus of this study has been on how to measure and describe the students' experience of the science learning activities, and consequently, to determine any particular emerging themes that stand out. There have been changes in the New Zealand Curriculum in relation to science teaching and learning since its implementation in 2007 and this study endeavoured to examine how these curriculum changes could have affected the learning environment.

Three different tools have been used to describe the learning environment and they are: the CLES "Constructivist Learning Environment Survey", student interviews and learning drawings. The findings of the CLES have provided validation data for the use of this particular quantitative instrument in New Zealand and show it to be a

reliable and valid quantitative instrument with the reliability and validity measures indicating a close concordance with other international studies. The CLES has also highlighted the construct validity of the five scales measured and provides clarity in identifying particular themes that can be explored in further depth. The learning drawings and student audio interviews have provided a wealth of qualitative material and proved to be a supportive triangulation method to the CLES findings. The data from the three different sources have helped to build an accurate picture of student perceptions of their learning in science.

7.3 ANSWERS TO RESEARCH QUESTIONS AND RESPONSES TO OBJECTIVES

7.3.1 Question one

What are the students' attitudes and perceptions of their experiences in Year 9 and 10 science?

The quantitative CLES survey titled "What happens in my science classroom" was used to help examine immediate students' attitudes and perceptions of their experiences in Year 9 and 10 science classes. The CLES scales and the corresponding items in the survey were associated with socio-constructivist practices in classrooms (Taylor, Fraser, & Fisher, 1997). The findings in this study indicated that the students perceived their learning environment to be moderately constructivist in nature; however there was variation between classes, genders and ethnic makeup. When comparing mean values, the Shared Control scale had the greatest statistical significance out of the five scales, including the greatest difference between students' actual and preferred perceptions. The Shared Control scale had the lowest mean values and the Student Negotiation scale had the highest mean values. Some striking ethnic differences were identified, in that NZ Māori students had significantly lower scores in the CLES compared with NZ European students across most scales but particularly in the Personal Relevance scale in the year 2009. In terms of gender there were only slight differences identified in the mean values across the scales and the distributions comparing relative percentages of students. The Student Negotiation scale was the only scale that had statistical significance but it was relatively small.

The question was posed "What does learning look like in your science class?" and the students were invited to draw a picture to respond to this question. The majority of the learning drawings identified classmates in the pictures and this suggested the magnitude of how important social presence was linked with how the students perceived their learning. Teacher and student positioning in the drawings showed the significance of the opportunities for the teacher and students to share control in the learning. The student interviews reported the importance of personal relevance in science lessons and the narratives provided evidence to suggest that there are students who found science lessons irrelevant and disconnected to their cultural identity.

7.3.2 Question two

How could the learning environment be changed to improve students' attitudes and perceptions?

The CLES analysis reported the Shared Control scale as having the greatest difference between the students' perception of the gap between what was actually happening in the science classroom and what they preferred to happen. For example, in year 2010 the actual mean value for Shared Control was 2.11 and the preferred mean value was 3.10. The t-value of 13.8 $p<0.001$ indicated the significance of this difference. This finding suggested how we might change the learning environment to provide further opportunities in the science lessons for students to plan learning activities with their teacher. Examples such as greater student choice in the lessons, time allocated for students to plan and discuss future activities, and tools such as mini-whiteboards in the science lab for both student and teacher to co-construct plans. A lack of personal relevance in the science lessons was also highlighted in the interviews and this coincided with the differences between the actual and preferred mean values in the CLES scale of Personal Relevance, particularly with Māori students. Using this analysis the researcher and the teachers determined that the learning environment could be enhanced with greater opportunity for the students to learn about recent global issues and contexts that were directly relevant to their personal lives.

7.3.3 Objective one

To provide validation data for the use of the CLES in New Zealand secondary schools and use qualitative student voice to further inform the project.

The results showed that the CLES used in this research is a particularly reliable and valid instrument for New Zealand. The Cronbach alpha scores ranged from 0.74 to 0.89 and shoed satisfactory internal consistency in both actual and preferred forms of the CLES. The alpha reliability values of this study were quite close to those reported in other overseas research studies in which the CLES was used. The discriminant validity was measured using each scale's mean correlation with the other scales and the range of 0.23 to 0.49 is acceptable. The quantitative and qualitative data were interrelated using the five CLES scales and so a common interpretative method was used to link the information together. As well as this, the qualitative student voice yielded a wealth of detail in the descriptions of the students' perceptions and attitudes to their science learning. The student interviews and learning drawings were of particular prominence in revealing further insight into the CLES scales and providing a successful method of triangulation with the CLES quantitative data.

7.3.4 Objective two

To determine the effect of a collaborative approach to learning on the attitudes and perceptions of students with teachers in this project.

The desire by teachers for using collaborative and cooperative learning strategies in secondary science classrooms has had heightened awareness in recent years (Brown & Thompson, 2000). The NZ curriculum suggest the capabilities for living and lifelong learning as key competencies for the 21st Century on page 12 "Key Competencies: Relating to others" (Ministry of Education, 2007). The Nature of Science strand also describes the need for students to work together, to share and examine their own and others' knowledge. Have these curriculum goals had an effect on changing student perceptions? Overall, this research has shown that the students perceived their immediate learning environment to be moderately constructivist in nature. The statistical analysis presented a picture that the students did perceive their

immediate learning environment as generally collaborative. There were overall mean actual values that ranged from 3.11 to 3.44 out of 5.00 in four scales of the CLES; The Shared Control scale means were an exception with lower values of 2.11 and 2.19. These ranges of numerical values do indicate that the learning environments have a moderate degree of collaborative practices and that the students' point of view was considered. The student drawings revealed how important the social world was to most of the students and that collaborative structures were in place in the lessons. Nevertheless, the preferred means are higher than the actual means across all the CLES scales in both years of the research. This suggests that the students prefer to accept a classroom environment with further collaborative structures in place. The Shared Control, Student Negotiation and Critical Voice scale preferred means ranged from 3.09 to 3.74 indicating that the students preferred greater control and negotiation in their learning. However, a number of student drawings and interviews revealed the teacher's role as dominant in the learning process and some of the drawings indicated the direction of communication flow mainly from the teacher to the students. Some of the drawings depicted students sitting in individual seats at desks with little exchange of ideas between students. These signs show the probability of objectivist classroom practices taking place and consequently there are further opportunities to explore with teachers the merits of constructivist learning activity in science lessons.

In conclusion, this research indicates a general view that the immediate learning environments are moderately collaborative with some degree of sharing and negotiating taking place. However, there are still further opportunities for teachers and students to develop greater collaborative structures in science lessons.

7.3.5 Objective three

To determine what could be done differently to improve the learning environments in secondary science classrooms in New Zealand schools and explore models of collaborative learning on how changes could be made.

The CLES findings and student voice have identified the following three distinct themes: The students respond positively to sharing control with the teacher; they

value the opportunity to negotiate their learning and discuss scientific issues and ideas with classmates; and they also can positively engage with personally relevant contexts in science lessons. These themes provide a clear direction for teacher professional learning in schools and they identify potential effective learning strategies that link with the preferred student perceptions. They have helped to focus what other possibilities could take place and they have taken into consideration all student responses on what could be done differently to improve the learning environment. The collection and more importantly the use of student voice was a significant tool to support change and the findings acted as a guide for teachers to reflect on the different modes of learning taking place in the classrooms. The professional learning sessions provided an opportunity for the teachers in this study to notice and consider their own students' perceptions and for some teachers this may have been a first experience. The planned teacher reflection opportunities helped to make improvements in the immediate learning environments and informed discussions around collaborative practice that can make positive and lasting changes.

7.3.6 Objective four

To examine the implementation and delivery of the New Zealand curriculum (2007), with particular reference to the key competencies and the Nature of Science strand and how this could affect changes to the learning environment.

Understanding how students perceive their learning environment in science lessons, with particular focus on social constructivist learning ideas used in this research, has helped to further examine the recently implemented 2007 New Zealand Curriculum. The Student Negotiation and Critical Voice scale descriptions reveal strong links with the "Key Competencies" described in the NZ Curriculum. These key Competencies are defined in the curriculum as capabilities for living and lifelong living. They are broad terms; however they highlight the importance for students to interact effectively with a diverse range of people and recognise different points of view. One of the Key Competencies also includes the importance for students to be actively involved in the community where they develop the understanding of balancing rights and roles in their immediate family and wider community. This study's findings show higher student preference in Student Negotiation and Critical

Voice. This highlights that perhaps greater attention is required by teachers to explicitly and intentionally teach science using specific strategies that support the development of key competencies. These key competencies are not just something that students will pick up along the way in science lessons. These two CLES scales reveal that the students do prefer to have greater voice in the classroom and want to have greater opportunity to discuss ideas with peers. Hence, if we wish students to be able to connect and negotiate their learning with other learners then this may require intentional and overt teaching strategies in our science programmes.

The Nature of Science overarching strand described in the NZ Curriculum has also posed a stimulating proposition in the changes to the nature of how we would like to teach science in the 21st Century. This strand has emphasis on the ideas around what science is, how students take action in a social environment and how they learn how scientists work. The Uncertainty scale in the CLES does show some close links with the Nature of Science strand. Overall, the Uncertainty scale provided evidence of the immediate student perceptions in terms of how they thought science has changed over time. The student interviews showed very similar patterns. The Uncertainty results from individual classes also provided results to the corresponding teachers and variations from class to class did exist. This has enabled fruitful teacher discussions with particular respect to the ideas of science as a dynamic socially valuable subject.

7.4 SIGNIFICANCE

This study is a contribution to the pool of knowledge on learning environment research. Data have been collected over three consecutive years in New Zealand's central North Island region. The CLES instrument has been validated as a valuable and useful instrument to make accurate measurements of constructivist learning in the science classrooms and has provided a wealth of data to inform teacher practice. This research also brings to the foreground some differences in Māori, Pacific and NZ European students' perceptions of learning in science using the CLES. It has reported statistically significant comparisons of the science-related perceptions of several subgroups of the study population. This includes the comparisons of gender

and ethnicity with particular focus placed on differences between NZ Māori, Pasifika and NZ European student perceptions.

Together with the CLES, the learning drawings and student interviews have proved to be powerful tools to develop further understanding of students' perceptions of their immediate learning environment in science. Both the use of the CLES and the qualitative student voice demonstrated an effective triangulation process that enabled the identification of significant themes. The implications of this were the promotion of effective learning in classrooms on the one hand, and the teachers' learning on the other. This connection rarely gets discussed in in-service teacher professional development, so this method of connecting the two became a significant way forward for teachers to look into their own learning by understanding their students' learning. The study has provided a robust research method using different tools for the researcher and the participating teachers to further develop effective professional development practices in secondary science education in New Zealand.

The overall findings highlight the overwhelming evidence that science learning environments have the ability to change and they need not be static. The study indicates that actual student perceptions have the potential to shift towards their preferred perceptions and perhaps what seems obvious, but clearly demonstrated, was that changing teaching practices does influence student perceptions of their learning. The differences between the actual and post actual mean values have emphasized how classroom climates are particularly dynamic and responsive. The ANOVA analysis of the CLES results showed statistical significance in the shifts of Personal Relevance, Critical Voice and Shared Control actual and post actual student perceptions. These results reveal that students prefer a more participatory and collaborative science learning environment and that teaching practices were changed as a result of the interpretation of student voice.

Finally, making change in learning environments is complex and challenging for teachers. The process of making that change can be fraught with all kinds of obstacles from ingrained structural school practices to very challenging student behaviour and everything in between. However, this research has significance in that it has revealed that the CLES and qualitative student voice help to make the plans for

change and indeed make positive shifts. It has focused on five scales of constructivist perception and these have framed the conversations around helping that change to come about.

7.5 LIMITATIONS

An obvious limitation of this study is that any of the conclusions drawn from the data relate only to this sample of students. The classes selected were from a mix of schools and students from different backgrounds and hence the overall interpretation reflects this particular sample. The geographic and demographical spread is localized only to the Bay of Plenty and Waikato regions and that extrapolation of the results to other regions of New Zealand is limited and cannot be assumed.

A second limitation is the size of the sample. In the Years 2009-2011 there were over 400 students involved in the research in each of the years. Some classes had changes to their teachers and many classes had small changes to the students in them. This did affect overall student perceptions and the resultant analysis needs to take account of this.

Finally there is also a limitation to the overall study in that we do not know anything about the students' ability and achievement in each of the classes. The associations between the learning environment perceptions of the students and their academic achievement would have been beneficial in measuring any connections. There have been some recent studies in New Zealand with regard to the associations of attitude, self-efficacy and achievement but little on constructivist perceptions of students and achievement. However, in retrospect, this study followed classes that were at Years 9 and 10 and consistent achievement assessment could be problematic due to the flexibility in the science programmes at those levels. Once at Year 11, students sit national qualifications and this would provide ample achievement data to compare with learning environment measurements.

7.6 SUGGESTIONS FOR FUTURE RESEARCH

There are opportunities for teachers to inquire and explore what effective teaching and learning looks like in classrooms but sometimes it can be daunting for teachers to know how to start. It can also be easy for teachers to be become professionally isolated in their classrooms and not have the opportunities to get to grips with their own learning. However, this study helped to provide an informed space for teachers and the researcher to encounter how students perceive their learning in science lessons. Further research of this nature would be important to continue to measure the changing perceptions of students in the future and explore further teaching techniques. An additional suggestion could be using a similar method but with different samples of student ethnicity to make comparisons. The CLES, other quantitative instruments and the student voice tools have provided a very effective method to do this and this process could be replicated in other regions of New Zealand.

This study has made a preliminary examination of the differences between Māori, Pacific and NZ European students' perceptions of science. It is possible that there are further opportunities for research around culture and equity, with particular attention to cultural and gender responsiveness in science learning. The scales of Shared Control and Personal Relevance have highlighted the differences between sub-groups of the sample and including gender differences; this could be considered for further research in earlier years at Intermediate schools and at Secondary schools in other regions of New Zealand to make comparisons. The New Zealand Curriculum has provided secondary science teachers with a clear vision about 21st Century learning and teaching but perhaps not presented how this vision might be implemented in practical steps. With the conclusions of this research in mind, creating further opportunities for teachers and schools to be directly involved in their own understandings of the New Zealand Curriculum using quantitative tools such as the CLES could be a way forward.

Further research could also be anticipated into the effective use of student learning drawings that were used in this study. The learning drawings provided an extensive range of details about the learning world of each student and there are enormous

possibilities to extend this pool of data and triangulate it with quantitative measures. The learning drawings were effective snapshots of students' perceptions of their learning and have provoked discussion from teachers.

7.7 FINAL COMMENTS

This study has measured student perceptions in Year 9 and 10 science classrooms from a group of New Zealand secondary schools and it has brought a focus to furthering our understanding of what collaborative learning environments are about. It has highlighted some ethnicity differences between NZ European, NZ Māori and Pasifika student perceptions of science lessons. From the overall results of the CLES and the qualitative student voice it seems the world of the 13-15 year old student in science is dynamic and particularly responsive to social presence, personal relevance and sharing control with the teacher.

Perhaps the most poignant but somewhat obvious finding using the CLES, is that the students preferred a greater collaborative and participatory learning environment than what was measured of the actual environment. Furthermore, the particular teaching practices that can help make the changes towards preferred learning environments required intentional and explicit implementation. In busy science lessons where there was plenty of activity going on, it was easy to make assumptions about students working together effectively in groups just because they were seen to be participating in a practical or a group task together. The CLES identified statistical significance in the differences between actual and preferred perceptions. These were perceptions of Shared Control, Critical Voice, Student Negotiation and Personal Relevance from both years 2009 and 2010.

Equally significant were the poignant narratives from the student interviews. Here the students revealed positive elements about the classroom climate that they were experiencing. They spoke of feeling empowered by having a choice about who they worked with and the opportunity to share ideas in a group. They enjoyed the teacher coming over to see them and talking about the science ideas with them rather than whole class discussions. Students appreciated the honesty of teachers who would

reason with them and ask them their opinions about current events that were connected with scientific issues.

However, there is an important implication of this research in that we cannot assume that we know how secondary school students view their science learning or that they will share common views about it. There can be very different social experiences of learning going on in the same science activity. The learning drawings revealed how students have developed a wide range of ways to represent learning in the science classroom, but one striking pattern to emerge from them was that for almost all the students, they depicted science lessons as socially interactive and that science learning always occurred with other classmates. This realisation of the importance of social relationships and social cooperation between classmates sometimes took the teachers and the researcher by surprise when they viewed the learning drawings for the first time.

This study has also found that students prefer relevant contexts that will engage them in their science lessons, with particular emphasis with links with their family interests and current events. Many of the narratives from the student interviews revealed the importance of personally relevant science activities that would connect themselves with what was happening outside of school. NZ Māori and Pasifika students had considerably lower mean scores in the Personal Relevance CLES scale compared with NZ European students.

Early on in this thesis there was a discussion about the links between collaborative and constructivist learning in classrooms. The first idea to stand out is the importance of students constructing meaning through communication and comparison and the second idea is that students are required to reconcile different viewpoints that may emerge through their experiences. As we have observed in this study the facilitation by teachers to support these ideas is a challenging act. Gilbert (2005) challenges our thinking about going forward in science education. She highlights that teachers could approach the teaching of science in ways that help students imagine themselves not as a spectator, an outsider looking in, but as a real practitioner of making meaning with others. To do this, teachers could emphasize, not the content knowledge of science but how a scientist might see or think about the science ideas. Designing

activities that allow students to imagine themselves being a scientist and to scaffold scientific ways of thinking could be a way forward. If students are to be collaborators and innovators, they need to be confident about working together and sharing a space that has opportunity to view their own thoughts mixed with quite different viewpoints from others.

Finally, the opportunity for teachers to inquire into their own learning by gaining knowledge of students' perceptions appears to be a useful process in making informed steps to bring about change in our science classes. There are varying different views of how students perceive their learning in science and what counts as effective learning for them can be sometimes lost in the hustle and bustle of lessons. The opportunity to analyse these different views of learning and teaching can be a powerful mechanism for teachers to reflect on their practice and make informed steps in their inquiry into their own learning.

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APENDENDICES

1. School and Teacher Information sheet and consent Form
2. Parents/Guardians and Students Information and consent Form
3. Information sheet for supervising teachers to administer the Questionnaire
4. CLES (Actual)
5. CLES (Preferred)

Appendix 1

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School and Teacher Information sheet and consent form

Learning Environments NZ Science study
2009-2011

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Dear Principal (named) and Teacher (named)

Further to our discussions around the proposed research project in Science at years 9 and 10 at your school (Named). I am asking written permission to carry out a research study of the learning environment. As you know this study is part of my research project for my doctorate degree at Curtin University of Science and Technology, Perth, Australia. I will be following one of your Year 9 science classes and their teacher for the remainder of this year and in 2010. I will be requesting to meet with the teacher at regular times through the project to discuss the data gathered and learning environment strategies. Approximately 12 schools have shown interest.

Consent to participate

Participation in the research is entirely voluntary. Schools may withdraw from the project without problem. This study will be carried out in term three and four in 2009 and continuing in 2010 by way of questionnaires, an audio taped interview and

further discussion with the science teacher to inform the study. In order to start this research part of the project we need to have signed permission slips from both the principal and the teacher in charge of the nominated class, see attached sheet. When you have signed the consent form, I will assume that you have agreed to participate and allow me to use the data in this research.

Confidentiality to the schools and students

The questionnaires are anonymous and only numbers will identify the students, their groups and their schools to retain their anonymity. School identity will not be stated on the instruments or in the audio interviews, only numbers determined by the teacher and the student. Ethnicity of the student will be voluntarily requested in the form of circling NZ/NZ Maori/Other. The audio interviews will not have names or any identifying information on them. The data will be stored securely at the University of Waikato for no more than 5 years and then destroyed. The information gathered from students will be kept and used to produce a set of data for analysis. Neither individual nor the school will be identified.

Purpose of the study

In the study I am interested in finding out ***how student learn about the world, their communication in the class, what relevance in what they learn and how they negotiate their learning.*** The purpose of the study is to investigate the constructivist model of learning and it will endeavour to provide an opportunity for the teacher and myself to explore collaborative learning strategies in science.

The study will be conducted during the normal classroom activities in the science lessons, the student interviews will take place in a room adjoining the laboratory for a quiet space.

Data collection

1. Quantitative analysis

Prof Darrell Fisher of Curtin University (Western Australia) will assist me with the analysis of the information collected and the study will focus on aspects, such as: student voice, involvement, self-efficacy, relevance; and students' science-related attitudes. The students will sit a questionnaire (instrument known as CLES). Only numbers will identify students and the school will retain its anonymity.

2. Qualitative analysis

There will be more formal interviews towards the end of the project with the students (in pairs or threes). The interview process will take approximately 15 minutes and the students will receive the set of five questions a few days before the interview takes place so that they can think about their responses before the interview. Parents/guardians will be given the opportunity to be present at the interviews.

Further information

Information from this data will form an integral part of my thesis and any subsequent publication of the results and conclusions of this project. Schools' names, teachers' names, Students' names or images will not be used in any written publication coming from the research without prior written permission (pseudonyms will be used). The interview transcript will not have the student's name or any other identifying information on it and in adherence to university policy, the interview audio tapes and transcribed information will be kept in a locked cabinet for five years, before it is destroyed.

Thank you for taking the time to read and consider this information. This research has been reviewed and given approval by Curtin University of Technology Human Ethics Committee (Approval Number XXXXX). Please complete and return the form to the classroom science teacher if you consent to your child participating in the research. Please do not hesitate to contact Professor Darrell Fisher or myself if you require further information or you have any questions or suggestions.

Yours sincerely,

Simon Taylor

Secondary Science Adviser

School Support Services University of Waikato

W 07 5775314

M 027 4955 317

Email: simont@waikato.ac.nz

Consent from Principal
School Name:
I have read and understood the information in this letter dated 18th August 2009. I consent to the involvement of my staff and students in the research project. *I understand that at any time I can withdraw my school from the research project*
Principal
Full Name:
Signature: Date:
Consent from Teacher
I have read and understood the information in this letter dated 18th August 2009. I consent to the involvement of myself in the research project. I understand that I can withdrawal my participation from the project.
Full name: Date: Signature:

Appendix 2

Consent form

Dear Parents/Caregivers,

I am asking permission to carry out a research study of the learning environment of your child's Year 9 science class. This study is part of my research project for my doctorate degree at Curtin University of Science and Technology, Perth, Australia. I will be following your child's science class for the remainder of this year and in 2010. I will be carrying out a study concerning students' attitudes and perceptions to science.

Consent to participate

Participation in the research is entirely voluntary and students may withdraw at anytime without problem. This study will be carried out in term three and four in 2009 and continuing in 2010 by way of questionnaires, an audio taped interview and further discussion with the science teachers to inform the study. In order to start this research part of the project we need to have signed permission slips from both a parent/ guardian and the student, see attached sheet. When you have signed the consent form, I will assume that you have agreed to participate and allow me to use your data in this research.

Confidentiality

The questionnaires are anonymous and only numbers will identify the students, their groups and their schools to retain their anonymity. Ethnicity of the student will be voluntarily requested in the form of circling NZ/NZ Maori/Pasifika/Other. The audio interviews will not have names or any identifying information on them. The data will be stored securely at the University of Waikato for no more than 5 years and then destroyed. The information gathered from students will be kept and used to produce a set of data for analysis. Neither individual nor the school will be identified.

Purpose of the study

In the study I am interested in finding out ***how student learn about the world, their communication in the class, what relevance in what they learn and how they negotiate their learning.*** The purpose of the study is to investigate the constructivist

model of learning and it will endeavour to provide an opportunity for the teacher and myself to explore collaborative learning strategies in science.

The study will be conducted during the normal classroom activities in the science lessons, the student interviews will take place in a room adjoining the laboratory for a quiet space.

Data collection

1. Quantitative analysis

Prof Darrell Fisher of Curtin University (Western Australia) will assist me with the analysis of the information collected and the study will focus on aspects, such as: student voice, involvement, self-efficacy, relevance; and students' science-related attitudes. The students will sit a questionnaire (instrument known as CLES). Only numbers will identify students and the school will retain its anonymity.

2. Qualitative analysis

There will be more formal interviews towards the end of the project with the students (in pairs or threes). The interview process will take approximately 15 minutes and the students will receive the set of five questions a few days before the interview takes place so that they can think about their responses before the interview. Parents/guardians will be given the opportunity to be present at the interviews.

Further information

Information from this data will form an integral part of my thesis and any subsequent publication of the results and conclusions of this project. Your child's name or image will not be used in any written publication coming from the research without prior written permission (pseudonyms will be used). The interview transcript will not have the student's name or any other identifying information on it and in adherence to university policy, the interview audio tapes and transcribed information will be kept in a locked cabinet for five years, before it is destroyed.

Thank you for taking the time to read and consider this information. This research has been reviewed and given approval by Curtin University of Technology Human Ethics Committee (Approval Number XXXXX). Please complete and return the form to the classroom science teacher if you consent to your child participating in the

research. Please do not hesitate to contact Professor Darrell Fisher or myself if you require further information or you have any questions or suggestions.

Yours sincerely

Simon Taylor

Secondary Science Adviser

School Support Services University of Waikato

W 07 5775314

M 027 4955 317

Email: simont@waikato.ac.nz

Consent form for Parents/Caregivers	
School Name:	
Child's Full Name:	
I have read and understood the information in this letter dated 18th August 2009. I consent to the involvement of my child in the research project. *I understand that at any time I can withdraw my child from the research project or my child can decide to withdraw from the research project.*	
Consent from Parent/Caregiver	
Full Name:	
Signature:	Date:
Consent from student	
Signature of student:	Date:

Appendix 3

INFORMATION SHEET FOR TEACHERS TO ADMINISTER THE QUESTIONAIRE: The CLES

"What happens in my science classroom"

- Students to take the questionnaire seriously and honestly-it is important we obtain trustworthy and valid data in the PLUTO project.
- Students are to complete the questionnaire individually, no discussion is required.
- Allow plenty of time for the students to complete the survey but usually about 15-20 minutes is sufficient. Provide the questionnaire to the students early in the day, preferably before lunchtime.
- Students/teacher to allocate a secret number e.g. 1-30 that will be used again for the other questionnaires, this is particularly useful for the statistics. Personal identity is not required.
- Students to keep a record of the secret number, so they won't forget it in the future
- Students to keep a record of their group/team number and other details
- Once the questionnaire has been completed by the students, please send them to Simon Taylor in the self addressed post paid envelope included in this envelope.

Many thanks for your support and if you have require any further assistance please contact

Simon

Mobile 0274955317 office 07 5775314

Appendix 4

What happens in my science classroom?

Student form

My Secret Number (Remember this!) eg 1-30	**My Group Number eg 1-10**
ETHNICITY (Circle one) ***NZ/ NZ Maori/Pasifika/Other***	**My gender** (Circle one) ***Male/ Female***

DIRECTIONS

1. **Purpose of the Questionnaire**
   This questionnaire asks you to describe important aspects of the science classroom which you are in right now. There are no right or wrong answers. This is not a test and your answers will not affect your assessment. Your opinion is what is wanted. Your answers will enable us to improve future science classes.

2. **How to Answer Each Question**
   On the next few pages you will find 25 sentences. For each sentence, circle only one number corresponding to your answer. For example:

		Almost Always	Often	Some-times	Seldom	Almost Never
In this class . . .						
8	The teacher asks me questions.	5	4	3	2	1

- If you think this teacher *almost always* asks you questions, circle the 5.
- If you think this teacher *almost never* asks you questions, circle the 1.
- Or you can choose the number 2, 3 or 4 if one of these seems like a more accurate answer.

3. How to Change Your Answer

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

8	The teacher asks me questions.	~~5~~	④	3	2	1

4. Completing the Questionnaire

Now turn the page and please give an answer for every question.

.

Learning about the world			Almost Always	Often	Some-times	Seldom	Almost Never
In this class . . .							
1	I learn about the world outside of school.		5	4	3	2	1
2	My new learning starts with problems about the world outside of school.		5	4	3	2	1
3	I learn how science can be part of my out-of-school life.		5	4	3	2	1
In this class . . .							
4	I get a better understanding of the world outside of school.		5	4	3	2	1
5	I learn interesting things about the world outside of school.		5	4	3	2	1
Learning about science			Almost Always	Often	Some-times	Seldom	Almost Never
In this class . . .							
6	I learn that science has changed over time.		5	4	3	2	1
7	I learn that science is influenced by people's values and opinions.		5	4	3	2	1
In this class . . .							
8	I learn about the different science used by people in other cultures.		5	4	3	2	1
9	I learn that modern science is different from the science of long ago.		5	4	3	2	1
10	I learn that science is about inventing theories.		5	4	3	2	1
Learning to speak out			Almost Always	Often	Some-times	Seldom	Almost Never
In this class . . .							
11	It's OK for me to ask the teacher "why do I have to learn this?"		5	4	3	2	1
12	It's OK for me to question the way I'm being taught.		5	4	3	2	1
13	It's OK for me to complain about activities that are confusing.		5	4	3	2	1
In this class . . .							
14	It's OK for me to complain about anything that prevents me from learning.		5	4	3	2	1
15	It's OK for me to express my opinion.		5	4	3	2	1

Learning to learn			Almost Always	Often	Some-times	Seldom	Almost Never
In this class . . .							
16	I help the teacher to plan what I'm going to learn.		5	4	3	2	1
17	I help the teacher to decide how well I am learning.		5	4	3	2	1
18	I help the teacher to decide which activities are best for me.		5	4	3	2	1
In this class . . .							
19	I help the teacher to decide how much time I spend on activities.		5	4	3	2	1
20	I help the teacher to decide which activities I do.		5	4	3	2	1
Learning to communicate			Almost Always	Often	Some-times	Seldom	Almost Never
In this class . . .							
21	I get the chance to talk to other students.		5	4	3	2	1
22	I talk with other students about how to solve problems.		5	4	3	2	1
23	I explain my ideas to other students.		5	4	3	2	1
In this class . . .							
24	I ask other students to explain their ideas.		5	4	3	2	1
25	Other students listen carefully to my ideas.		5	4	3	2	1
			Almost Always	Often	Some-times	Seldom	Almost Never

If you wish you can add any written comments about your learning here:

Appendix 5

What I wish would happen in my science classroom?

Student form

My Secret Number (Remember this!) e.g. 1-30	**My Group Number eg 1-10**
ETHNICITY (Circle one) ***NZ/NZ Maori/Pacifika/Other***	**My gender** (Circle one) ***Male/Female***

DIRECTIONS

1. **Purpose of the Questionnaire**
   This questionnaire asks you to describe important aspects of the science classroom which you are in right now. There are no right or wrong answers. This is not a test and your answers will not affect your assessment. Your opinion is what is wanted. Your answers will enable us to improve future science classes.

2. **How to Answer Each Question**
   On the next few pages you will find 25 sentences. For each sentence, circle only one number corresponding to your answer. For example:

		Almost Always	Often	Some-times	Seldom	Almost Never
In this class I wish that . . .						
8	The teacher would ask me questions.	5	4	3	2	1

- If you think this teacher *almost always* asks you questions, circle the 5.
- If you think this teacher *almost never* asks you questions, circle the 1.
- Or you can choose the number 2, 3 or 4 if one of these seems like a more accurate answer.

3. How to Change Your Answer

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

8	The teacher asks me questions.	~~5~~	④	3	2	1

4. Completing the Questionnaire

Now turn the page and please give an answer for every question.

Learning about the world		Almost Always	Often	Some-times	Seldom	Almost Never
In this class I wish that . . .						
1	I learned about the world outside of school.	5	4	3	2	1
2	My new learning would start with problems about the world outside of school.	5	4	3	2	1
3	I could learn how science can be part of my out-of-school life.	5	4	3	2	1
In this class I wish that. . .						
4	I would get a better understanding of the world outside of school.	5	4	3	2	1
5	I learned interesting things about the world outside of school.	5	4	3	2	1

Learning about science		Almost Always	Often	Some-times	Seldom	Almost Never
In this class I wish that. . .						
6	I learned that science has changed over time.	5	4	3	2	1
7	I learned how science is influenced by people's values and opinions.	5	4	3	2	1
In this class I wish that. . .						
8	I learned about the different science used by people in other cultures.	5	4	3	2	1
9	I learned that modern science is different from the science of long ago.	5	4	3	2	1
10	I learned that science is about inventing theories.	5	4	3	2	1

Learning to speak out		Almost Always	Often	Some-times	Seldom	Almost Never
In this class I wish that. . .						
11	It was OK for me to ask the teacher "why do I have to learn this?"	5	4	3	2	1
12	It was OK for me to question the way I'm being taught.	5	4	3	2	1
13	It was OK for me to complain about activities that are confusing.	5	4	3	2	1
In this class .I wish that . .						
14	It was OK for me to complain about anything that prevents me from learning.	5	4	3	2	1
15	It was OK for me to express my opinion.	5	4	3	2	1

Learning to learn	Almost Always	Often	Some-times	Seldom	Almost Never
In this class .I wish that . .					
16 I could help the teacher to plan what I'm going to learn.	5	4	3	2	1
17 I could help the teacher to decide how well I am learning.	5	4	3	2	1
18 I could help the teacher to decide which activities are best for me.	5	4	3	2	1
In this class .I wish that . .					
19 I could help the teacher to decide how much time I spend on activities.	5	4	3	2	1
20 I could help the teacher to decide which activities I do.	5	4	3	2	1
Learning to communicate	Almost Always	Often	Some-times	Seldom	Almost Never
In this class I wish that . . .					
21 I got the chance to talk to other students.	5	4	3	2	1
22 I could talk with other students about how to solve problems.	5	4	3	2	1
23 I had the chance to explain my ideas to other students.	5	4	3	2	1
In this class I wish that . . .					
24 I could ask other students to explain their ideas.	5	4	3	2	1
25 Other students could listen carefully to my ideas.	5	4	3	2	1
	Almost Always	Often	Some-times	Seldom	Almost Never

If you would like to, you can add any written comments about what you wish would happen with regard to your learning in the your science classroom, here: