

Science and Mathematics Education Centre

**Cooperative Learning in Science Classes in the United Arab
Emirates: Learning Environment, Attitudes, Motivation,
Engagement and Career Aspirations**

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Doctor of Philosophy
of
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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 acknowledgement has been made.

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

Nadine Khalil

Signature: 

Date: September 29th 2015

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ABSTRACT

The overarching aim of my study was to examine the impact of cooperative learning on students' perceptions of the learning environment and their outcomes (attitudes, motivation, engagement and aspirations) in science classes in Abu Dhabi, United Arab Emirates (UAE). This thesis reports the results of a study of students' and teachers' perspectives on the use of cooperative learning strategies in science classrooms in Abu Dhabi.

A multistrand approach, in which two separate but interrelated studies were carried out sequentially, was used. To complement this approach, a mixed-methods design was employed to collectively identify the strengths and non-overlapping weaknesses of both qualitative and quantitative methods. The approach involved, in the first phase, the collection of quantitative data from a sample of 784 students (419 females and 365 males). Of these, 290 students were in 12 classes in which cooperative learning was implemented effectively, and 494 students were in 22 classes that were in classes in which cooperative learning was not implemented effectively. The students were selected from 34 lower secondary science classes in eight public schools in Abu Dhabi. The ages of the students ranged from 12 to 15. In the second phase, qualitative observation data was gathered from 17 female teachers, seven of whom were considered to be implementing cooperative learning in an exemplary manner and 10 of whom were not. In-depth information was also collected from case study teachers, comprising the seven teachers who were implementing cooperative learning in an exemplary manner.

Quantitative data were collected using two instruments. The first instrument, a modified and translated version of the What Is Happening In this Class (WIHIC) questionnaire, was used to assess students' perceptions of the learning environment. The second instrument, the Attitudes towards Cooperative Learning (ACL) questionnaire, was used to assess students' attitudes, motivation, engagement and career aspirations in science. In both cases, the instruments were translated into Arabic, using a rigorous process of back translation, to make them usable in UAE classrooms, where English was a second language.

As a first step, evidence was provided to support the reliability and validity of the Arabic/English versions of the instruments when used in the UAE context (Research Question 1). For both instruments, there was strong evidence to support the reliability of the instruments in terms of their factor structure, internal consistency and ability to differentiate between classes.

To examine the relationships between students' perceptions of the learning environment and their attitudes, motivation, engagement and career aspirations in the field of science (Research Question 2), simple correlation and multiple regression analysis was used. The results of the simple correlations indicated that all five learning environment scales were statistically significantly ($p < 0.01$) and positively related to each of the eight outcomes. Further, the multiple correlations were positive and statistically significant ($p < 0.01$) for all eight attitude outcomes.

To identify which of the learning environment scales contributed to the variance in students' attitudes, the standardised regression weights (β) were examined. The results indicated that the learning environment scales were positively related to different attitude scales. Specifically, student cohesiveness was a statistically significant ($p < 0.01$) independent predictor of learning goal orientation, task value, social implications and science career aspirations. Teacher support and equity were significant ($p < 0.01$) independent predictors of all eight attitude outcomes, with one exception (the relationship between teacher support and engagement). The involvement scale was found to be a significant ($p < 0.01$) independent predictor of self-efficacy, self-regulation, task value, engagement and science career aspirations. Finally, cooperation was a significant ($p < 0.05$) independent predictor of self-efficacy, learning goal orientation, task value, social implications, engagement and adoption of scientific attitudes.

A one-way multivariate analysis of variance (MANOVA) was used to examine whether statistically significant differences existed for students in classes in which cooperative learning strategies were implemented effectively ($n=290$ students in 12 classes) and those who were not implemented effectively ($n=494$ students in 22 classes) (Research Question 3). For the learning environment scales, teacher support ($p < 0.01$, effect size=0.21 standard deviations) and cooperation ($p < 0.05$, effect

size=0.15 standard deviations) were statistically significantly different for students who were exposed to cooperative learning and those who were not. For the attitude scales, statistically significant ($p<0.05$) differences were found for three of the eight scales, these being self-efficacy (effect size=0.18 standard deviations), task value (effect size=0.29 standard deviations) and science career aspirations (effect size=0.21 standard deviations). In all cases, the students who were exposed to effective cooperative learning strategies scored higher for these constructs than did their counterparts who were not exposed to effective cooperative learning.

A two-way MANOVA was used to determine whether exposure to cooperative learning was differentially effective for male and female students in terms of their attitudes towards science (Research Question 4). The sample of 784 students in 34 classes (7 classes of which were exposed to effective cooperative learning and 27 classes who were not) was used for the analysis. Because the two-way MANOVA yielded statistically significant results overall for each of the three effects (exposure to cooperative learning, gender, and exposure to cooperative learning versus gender), the univariate ANOVA was interpreted for each dependent variable for each of the three effects. There were statistically significant interactions ($p<0.05$) between the method of instruction and gender for six of the eight attitude scales, these being self-efficacy, task value, self-regulation, engagement, adoption of scientific attitudes and science career aspirations.

In the second phase of the study, observation data was gathered from 17 female teachers; of these, seven case study teachers provided in-depth information (teacher journals, classroom observations, interviews, sample activities and lesson plans) to address the fifth research question: What are the benefits and challenges of implementing cooperative learning as part of the teaching and learning process? Analysis of the data indicated that there were both benefits and challenges in implementing cooperative learning strategies in classes in the UAE. During the analysis of the data, four major themes emerged. Firstly, the teachers found that the implementation of cooperative learning strategies led to increased cooperation and reduced behaviour problems among students. Secondly, teachers reported that they were better able to cater for students of differing abilities when they had assigned students into their cooperative learning teams. Thirdly, the benefits and challenges

associated with assessing students in teams were reported by teachers. Finally, issues associated with the lack of sufficient resources were found to have impacted on the teachers' ability to implement cooperative learning effectively in science lessons.

This study has extended the field of research into learning environments, as it is one of the first studies of its kind to examine the impact of cooperative learning in science classes on a range of student outcomes (attitudes, motivation, engagement and science career aspirations) in Abu Dhabi, UAE. Specifically, this study has contributed to the literature on gender differences in terms of the impact cooperative learning in science has on students' attitudes, motivation and engagement in science as well as on the science career aspirations of students. The results offer important insights into how the implementation of a cooperative learning environment could impact student attitudes towards science. The findings will appeal to a wide audience as they shed light not only on how cooperative learning can be an effective means of improving students' attitudes towards science, but also on the challenges and benefits of implementing cooperative learning from the teachers' perspective. The findings, therefore, are likely to be of interest to researchers, educators and policy makers.

LIST OF ACRONYMS

Acronym	Meaning
ACL	Attitudes towards Cooperative Learning
ADEC	Abu Dhabi Education Council
ANOVA	Analysis Of Variance
ATCLS	Attitude Towards Chemistry Lessons Scale
ATS	Attitude Towards Science Scale
ATSSA	Attitudes Toward Science in School Assessment
CES	Classroom Environment Scale
CLASS	Colorado Learning Attitudes about Science Survey
CLESS	Constructivist Learning Environment Survey
CUCEI	College and University Classroom Environment Inventory
DAS	Dimensions of Attitude toward Science
DELES	Distance Education Learning Environments Survey
ICEQ	Individualised Classroom Environment Questionnaire
IT	Information Technology
LEI	Learning Environment Inventory
MANOVA	Multivariate Analysis Of Variance
MCI	My Class Inventory
QTI	Questionnaire on Teacher Interaction
SAI	Scientific Attitude Inventory
SALES	Student Adaptive Learning Engagement Survey
SLEI	Science Laboratory Environment Inventory
STEM	Science Technology Engineering and Mathematics
TIMMS	Trends in International Mathematics and Science Study
TOSRA	Test of Science-Related Attitudes
TROFLEI	Technology-Rich Outcomes-Focused Learning Environment Inventory
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America
WIHIC	What Is Happening In this Class

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CHAPTER 1

RATIONALE AND CONTEXT

1.1 Introduction

This study is seated within a large scale educational reform project currently underway in Abu Dhabi. In 2005, the Abu Dhabi Education Council (ADEC) adopted a system-wide initiative, known as the New School Model, which involved a shift from traditional teaching and learning to that of constructivist learning. The New School Model was developed to drive improvements in education delivery through new curricula and teaching methods. One requirement of this new initiative was the implementation of cooperative learning, introduced in a bid to advance students as creative, independent thinkers and problem-solvers who acquire knowledge through exploration and experimentation. Within this new model, educators were expected to move away from ‘rote memorisation’ towards the use of interactive and varied teaching methods in an integrated learning environment. Thus, cooperative learning was introduced into science lessons as a means of achieving the requirements of the new model.

This study examines the impact of the effective use of cooperative learning, in terms of students’ perceptions of the learning environment and a range of important student attitudes in science classes in Abu Dhabi, United Arab Emirates (UAE). This chapter provides a rationale and background to the study and introduces the thesis under the following headings:

- Context of the study (Section 1.2);
- Theoretical framework (Section 1.3);
- Research questions (Section 1.4);
- Significance of the research (Section 1.5); and
- Thesis overview (Section 1.6).

1.2 Context of the Study

To put the significance of this study into perspective, this section describes the context of the study and is organised under the following headings: history and background of the United Arab Emirates (Section 1.2.1); the education system in Abu Dhabi (Section 1.2.2); and the framework of cooperative learning (Section 1.2.3).

1.2.1 History and Background of the United Arab Emirates

The United Arab Emirates (UAE) is located in the Arabian Gulf and borders Saudi Arabia, Qatar and the Sultanate of Oman. The UAE was founded by the late Sheikh Zayed Al-Nahyan (also known as the Founding Father) on December 2nd 1971. The UAE is made up of seven Emirates, namely, Dubai, Ajman, Umm Al-Quwain, Ras Al-Khaimah, Sharjah, Fujairah and the capital city, Abu Dhabi. The main religion practised in the UAE is Islam and the official language is Arabic. Although a fairly young country, the UAE has rapidly developed and diversified in many aspects such as infrastructure, economics and education.

Parts of the UAE were settled as far back as the third millennium BC and its early history fits the nomadic, herding and fishing pattern that is typical of the broader region. Back then, Abu Dhabi consisted of several hundred palm huts, a few coral buildings and the Rulers Fort. Not long ago, the UAE was a land of desert sparsely populated by proud and resourceful nomadic Bedouin (desert dweller) tribes, fishing villages and date farmers. The Bedouin tribe was the principal building block of UAE society and lived in varied terrain, moving between the ocean (where pearl diving and fishing were the main forms of sustenance), the desert (moving as nomads between grazing areas for camels and herds) and the oasis (where water sources and irrigation allowed for farming of dates and vegetables). The luxuriant date farms in Al Ain and irrigated terraced gardens in the mountain wadis (valleys) can still be seen today. The Bedouin were known for their resourcefulness and independence in a harsh (hot and humid) environment. Their code of hospitality continues today among the modern Emirati population, who show great respect and honour to guests (ZU,

2015). However, life today in the Emirates bears little resemblance to that of 40 years ago.

The Portuguese arrived in 1498 when Vasco de Gama circumnavigated the Cape of Good Hope. Portuguese forts and the forts of their local supporters are evident in and around the various Emirates and nearby Oman. The British then followed, asserting their naval power to safeguard trade links to India. The British came into conflict with the Qawasim tribal group, a seafaring clan whose influence extended to the Persian side of the Gulf. As a result, the area acquired the name "Pirate Coast". In the 1820s, the British fleet, known as the Qawasim navy, imposed a General Treaty of Peace on the nine Arab sheikhdoms, and established a garrison in the region. The area became known as the Trucial Coast until the creation of the UAE in 1971. During the colonial era, the British were primarily concerned with protecting their links to India and keeping any European competitors out of the area. Throughout this period, the main power among the Bedouin tribes of the interior was the Bani Yas tribal confederation, made up of the ancestors of the ruling families of modern Abu Dhabi (Al Nahyan) and Dubai (Al Maktoum). Descendants of these families rule Abu Dhabi and Dubai to this day (ZU, 2015).

As the 20th century unfolded, the region remained a quiet backwater of fishing villages, pearling, camel herding and farming in the oasis. In the 1930s the pearl industry was devastated by the Japanese invention of the cultured pearl, creating significant hardship for the local population, with the loss of their largest export and main source of earnings. However, all that changed with the discovery of oil. The first oil concessions were granted in 1939 by Sheikh Shakhbut bin-Sultan Al Nahyan, but oil was not found for another 14 years. At first, oil money had a marginal impact. In Abu Dhabi, a few low-rise concrete buildings were erected, and the first paved road was completed in 1961, but Sheikh Shakhbut, uncertain whether the new oil royalties would last, took a cautious approach, preferring to save the revenue rather than investing it in development. His brother, Zayed bin Sultan Al Nahyan, saw that oil wealth had the potential to transform Abu Dhabi (ZU, 2015).

The ruling Al Nahyan family decided that Sheikh Zayed should replace his brother as Ruler and carry out his vision of developing the country. Exports from Abu Dhabi

began in 1962, turning the poorest of the Emirates into the richest. Dubai concentrated on building its reputation as the region's busiest trading post. Then, in the mid-1960s, Dubai found oil of its own. On August 6 1966, with the assistance of the British, Sheikh Zayed became the new ruler (Al-Fahim, 1995).

In 1968 Britain announced its intention to leave the Gulf. The original plan was to form a single state consisting of Bahrain, Qatar and the Trucial Coast states; however, differing interests made it unsuccessful. Negotiations eventually led to the independence of Bahrain and Qatar and the formation of a new federation - the United Arab Emirates. In July 1971, six of the Trucial States (Abu Dhabi, Dubai, Sharjah, Umm al-Quwain, Ajman and Fujairah) agreed on a Federal Constitution for achieving independence as the United Arab Emirates. The UAE became independent on 2 December 1971. The remaining sheikhdom, Ras Al Khaimah, joined the United Arab Emirates in February 1972. Sheikh Zayed of Abu Dhabi took office as the first President of the United Arab Emirates (ZU, 2015).

Today, the UAE is a major international tourist and business centre as well as one of the most modern, stable and safe countries in the world. It has one of the highest per capita incomes in the world at nearly USD 25,000. The UAE has approximately 10% of the world's total known oil reserves, with about 90% of this in Abu Dhabi and 10% in Dubai (ZU, 2015). While the Abu Dhabi reserves are expected to last another 100 years, at present rates of production, Dubai's reserves will last only another ten years.

The UAE is no longer solely reliant on oil and gas revenues. Today, the oil sector contributes 30% of the country's GDP. Thanks to the foresight of the UAE leaders, trade, tourism, real estate and construction are large contributors, most notably in Dubai (ZU, 2015).

1.2.2 Education System in Abu Dhabi

One of the UAE's highest priorities has always been education. The importance of this priority was reflected in the words of His Highness (H.H.) the late Sheikh Zayed Bin Sultan Al Nahyan, founder of the UAE, who noted, "The greatest use that can be

made of wealth is to invest it in creating generations of educated and trained people”. His Highness went on to say “The real asset of any advanced nation is its people, especially the educated ones, and the prosperity and success of the people are measured by the standard of their education” (ZU, 2015).

The education system in Abu Dhabi (operating across its three regions of Abu Dhabi, Al Ain and the Western Region) consists of approximately 296 public schools which range from kindergarten to grade 12. The core learning years (from Grade 1 to 12) are divided into three Cycles (known as Cycles 1, 2 and 3). Cycle 1 caters for students in Grades 1 to 5 (6 to 11 years of age). Cycle 2 caters for students in Grades 6 to 9, known as middle school in some countries (12 to 14 years of age). Cycle 3 caters for students in Grades 10 to 12 (15 to 17 years of age). Special education programs within the schools cater for students with special educational needs. There are 32 adult education centres which accommodate the mature age students and include evening classes and female-only courses. Abu Dhabi also has around 185 private schools that cater for approximately 200,000 students of different nationalities. Private schools comprise approximately 50,000 Emirati students which make up 25% of the total number of students registered in private schools. There are 18 higher education institutions, enabling students to pursue post-secondary study to advanced levels.

The government of Abu Dhabi is strongly committed to supporting and funding public education in the Emirate. The government’s aim is to deliver education that is comparable to the highest international standards. This educational delivery was, at the time of writing this thesis, driven by the Abu Dhabi Education Council (ADEC) which sought to develop education and educational institutions in the Emirate of Abu Dhabi. ADEC was, at this time, responsible for implementing innovative educational policies, planning programs that aimed to improve education, and supporting educational institutions and staff to achieve the objectives of national development in accordance with the highest international standards (ADEC, 2013).

At the time of writing this thesis, ADEC was driven by the philosophy that all individuals are capable of learning and should have access to the best possible level of education. ADEC encouraged all students to develop their strengths, skills and

passions so that they could contribute to the development of the UAE and become active participants in the world around them.

Since 2005, Abu Dhabi's 296 public schools have been at the centre of a transformational reform agenda designed to elevate student performance and educational delivery (curriculum, assessment, teaching methods) to international standards. The aim of this reform was to shift the learning and teaching in science classes from a teacher-centred, rote memorisation to that which is student-centred, hands-on and collaborative. Thus, in 2005, ADEC adopted a new approach to learning (New School Model), developed to tackle existing challenges in public schools and to drive improvements in educational delivery. The New School Model provided a comprehensive foundation for learning by improving teaching quality and learning environments. The New School Model will be implemented in phases, reaching all grade levels in middle (Cycle 2) schools by 2016 (ADEC, 2013). In line with ADEC's philosophy, and the New School Model approach, a revised science curriculum involving the use of the cooperative learning approach has been put into practice in many public schools in the Emirate of Abu Dhabi. Science educators, supported by science education advisors, have been required to implement cooperative learning in all areas of pedagogy, curriculum and assessment. Thus, the study reported in this thesis examines the impact of cooperative learning on students' perceptions of their learning environment and attitudes towards science.

The implementation of the New School Model has been supported in schools by education advisors, whose primary role, at the time of writing this thesis, involved the upskilling and support of teachers. In particular, education advisors provided teachers with training seminars and served as coach and mentor, working alongside teachers to implement the New School Model and, more specifically, the cooperative learning and assessment teaching and learning approach.

1.2.3 Cooperative Learning Framework

In an effort to enhance academic achievement and scientific literacy across many countries, cooperative teamwork was introduced in science classrooms and laboratories in the late 1970s (Denrell, 2005). Cooperative small-group learning has

since been widely recognised as a teaching strategy that promotes learning and socialisation (Cohen, 1994). In cooperative learning, the classroom is structured into cooperative teams of learners in which students work together to accomplish shared goals (Lazarowitz & Hertz-Lazarowitz, 1998; Levitt, 2002; Lin, 2006; Treagust, 2007). It is this focus that helps students to develop a sense of ‘group’ as they recognise the need to help and support each other’s learning and understanding (Gillies, 2002; Slavin, 1995).

When students work cooperatively, they learn to give and receive help, share ideas, listen to other students’ perspectives, seek new ways of clarifying differences, resolve problems, and construct new understandings from engaging in these processes (Gillies, 2003b; Webb, Troper & Fall, 1995). Okebukola (1985) identified three major ways in which students can interact with each other: (1) competitive, where students vie with classmates to be the best; (2) individualistic, where students work independently and ignore each other; and (3) cooperative, where students work in small groups, “sink or swim together”, ensuring that everyone masters the assigned learning material. Many recent studies (Altinok & Acikgoz, 2006; Bilgin, 2006; Bilgin & Geban, 2004; Bilgin & Karaduman, 2005; Doymus, Simsek & Bayrakceken, 2004; George, 2005) have shown that cooperative learning has positive effects on students’ attitudes towards science.

Since 2010, it has been a requirement that cooperative learning is implemented in Abu Dhabi’s public schools. Thus, ADEC has made it a requirement for all science teachers to conduct their lessons in a student-centred, hands-on learning environment. Innovative teaching methods have been introduced to develop students as creative, independent thinkers and problem-solvers that acquire knowledge and understanding through exploration and experimentation. As such, educators are moving away from ‘rote memorisation’ towards the use of interactive and varied teaching methods that support the development of problem-solving and independent thinking skills in an integrated learning environment.

To date, there have not been any reports of studies in this area of educational research in the United Arab Emirates. Thus, this research study investigated the

effects of implementing cooperative learning and assessment on student attitudes in science classes in the United Arab Emirates.

Given that the implementation of cooperative learning might be slightly different in the UAE context, the following provides a brief description of ADEC's requirements in terms of the grouping (including role description and responsibilities) (Section 1.2.3.1) and assessment (Section 1.2.3.2) of students when using cooperative learning.

1.2.3.1 Grouping and Group Roles

Unlike Kagan's (1994) cooperative learning group design, in which heterogeneous teams were recommended, the implementation of cooperative learning in the UAE context requires teachers to group students with similar abilities (homogeneous groups) especially during team assessments (such as team tests) (ADEC, 2013). At the time of writing this thesis, students in each of the cooperative learning groups were assigned roles which included a manager, a technician and a recorder/reporter, each with specific duties to fulfil. Specific responsibilities were assigned to students and marks were deducted for the group's work if students did not carry out their assigned duties during assessments. The responsibilities of each role differed. The manager's role was to ensure that each student was on task and carrying out their respective duties within the time frame assigned by the teacher. The recorder/reporter's role was to document the results, answer questions following group discussion and to provide feedback to the class. The technician's role was to collect the equipment, carry out the hands-on activity, tidy up the work area and return the equipment, as per the teacher's instructions. If the group consisted of four students, as opposed to three the recorder/reporter role was divided into two separate roles.

1.2.3.2 Assessment

A requirement, from the science curriculum specialist in ADEC, was that the students were to be assessed in their assigned groups. The assessment involved 80% of the weighting to be determined as a group and 20% of the term's weighting to be

based on individual test assessments. Throughout the year, the teachers were required to use a variety of assessment approaches to provide a holistic picture of each student's abilities and skill levels. With the exception of the individual tests, students were assessed using a selection of assessment tasks, including, experiments, team tests, investigations, extended research and enquiry. For example, teachers might select enquiry (40%), investigations (20%), team tests (20%) and individual tests (20%) to obtain a total of 100% for the term's total assessment grade. Teachers were free to select the type of assessment and its corresponding weighting as long as they assigned each type of assessment between 20% and 40% to make up the 100% total for the term. Another example of obtaining 100% for the term's total might be team tests (20%), individual tests (20%), extended research (30%) and enquiry (30%).

1.3 Theoretical Framework

A sequential design was employed to collectively draw on the strengths and non-overlapping weaknesses of both qualitative and quantitative methods (Teddlie & Tashakkori, 2006). This multistrand approach was carried out in two phases. The first phase involved the collection and analysis of quantitative data from a large sample ($N=784$) of students. The second phase involved the collection and analysis of qualitative data using a sample of 17 teachers (of whom seven were case study teachers).

A paradigm is the basic belief system or worldview that guides the investigator, not only in choices of method but also in fundamental ways that are ontological (nature of reality), epistemological (nature of the relationship between the knower and what can be known) and methodological (means by which the knower comes to know) (Guba & Lincoln, 1994). Of the four major paradigms identified in educational research, the post-positivist and interpretivist paradigms guided this study.

The study commenced from a more positivist approach during the first phase and was consequently more objectivist in nature. As such, this phase of the study relied on the collection and analysis of quantitative data to provide an overview of the students' perceptions and attitudes of their science classrooms.

In the second phase, the study employed an interpretative framework that drew on elements of the constructivist paradigm (Morse, 2003). This phase relied on the collection and analysis of qualitative information. Interpretive researchers often address the processes of interaction among individuals and the specific contexts in which people live and work in order to understand the historical and cultural settings of the participants (Cresswell, 2009). In this phase of the study, the approach involved studying teachers in their natural settings, the classrooms and science laboratories, whilst they were implementing the cooperative learning teaching and learning approach.

The constructivist approach (Schwandt, 2000) from which the study drew maintains ontologically that the reality of a certain social phenomenon is multiple and constructed by individuals; that is, not a single objective reality but multiple realities are constructed in the minds of the people under study. This was assumed to be the case since this study had many subjects each with their own views. Epistemologically, this paradigm maintains that the investigator and respondents co-create understandings and when reporting their findings, researchers usually acknowledge their subjectivity. The data collected from teachers helped to provide a more accurate picture of the benefits and challenges they faced as they implemented cooperative learning in their science lessons.

Within the constructivist framework, it is important to acknowledge that the researchers themselves influence the research process (Marshall & Rossman, 1999). As a result, a reflection on my role as researcher has been taken into consideration so that any biases can be minimised. Given the importance of understanding the subjects' cultural practices and the meanings they bring to them, constructivists examine the phenomenon where it occurs (Denzin & Lincoln, 2000). As such, the observations and other qualitative information were collected in the science classrooms and laboratories of the schools under investigation.

1.4 Research Questions

The overarching aim of the proposed study was to examine the impact of cooperative learning on students' perceptions of the learning environment and their outcomes (attitudes, motivation, engagement and career aspirations) in science classes in Abu Dhabi, United Arab Emirates. The specific research questions, formulated to address this aim, are outlined below.

To ensure that the results of this study were based on strong foundations and that the evaluation was meaningful to the UAE context, it was important to provide evidence to support the validity and reliability of the questionnaires when used with this sample. Thus, the first research question was:

Research Question #1

Are modified and translated versions of the What Is Happening In this Class (WIHIC) and Attitudes towards Cooperative Learning (ACL) instruments, which assess students' perceptions of the learning environment, attitudes, motivation, engagement and aspirations, valid and reliable when used in the UAE?

Studies investigating the effects of cooperative learning report that students who work together in small groups learn better, build better relationships with peers and retain more information than those working alone (Bilgin, 2006; Bilgin & Geban, 2004; Kincal, Ergul & Timur, 2007; Senol, Bal and Yildirim, 2007; Wachanga & Mwangi, 2004; Zacharias & Barton, 2004). Additionally, studies have provided strong evidence to suggest that cooperative learning has a positive effect on students' attitudes towards science (Altinok & Acikgoz, 2006; Bilgin 2006; Bilgin & Geban, 2004; Bilgin & Karaduman, 2005; Doymus et al., 2004; George, 2005; Jones et al., 2003).

To ascertain whether associations exist between students' perceptions of the learning environment and their attitudes towards science, motivation and engagement in science and science-career aspirations, the second research question was:

Research Question #2

What relationships exist between students' perceptions of a cooperative learning environment and their:

- a. Attitudes towards science;
- b. Motivation and engagement in science; and
- c. Science-related aspirations?

The central focus of this study was to examine the effectiveness of cooperative learning as a teaching and learning strategy in science classes in Abu Dhabi. To examine whether differences exist for students who were exposed to effective cooperative learning strategies and those who were not, in terms of their perceptions of the learning environment and attitudes towards science, the third question was:

Research Question #3

Do differences exist for students in classes in which cooperative learning strategies are implemented effectively and those who are not in terms of:

- a. Perceptions of the learning environment;
- b. Attitudes towards science;
- c. Motivation and engagement in science; and
- d. Science-related aspirations?

Past research has reported that males have more positive attitudes towards science than females (Cannon & Simpson, 1985; Francis & Greer, 1999; Weinburgh, 1995). However, George (2006) and Simpson and Oliver (1985) claim that, although males start off with more positive attitudes than females, males' attitudes decline faster. In contrast, other researchers have reported that females' attitudes decline faster (Doherty & Dawe, 1985; Hadden & Johnstone, 1983). Since there are many differences in past findings, it was important to identify the differential effectiveness of employing cooperative learning methods of instruction according to student gender, thus the fourth question was:

Research question #4

Is exposure to cooperative learning differentially effective for male and female students in terms of their perceptions of the classroom learning environment and attitudes towards science?

Past studies investigating the implementation of cooperative learning have highlighted both positive and negative experiences from the teachers' perspectives. Thus, to better understand the thoughts and experiences of teachers whilst implementing cooperative learning and its effectiveness as a teaching and learning strategy, the fifth research question was:

Research Question #5

What are the benefits and challenges of implementing cooperative learning as part of the teaching and learning process?

1.5 Significance of the Research

Science is important in many aspects of today's society, yet there appears to be fewer students opting to study science courses in high school and university, and fewer teachers interested in teaching science. To address this growing trend, it is essential for students to develop positive attitudes towards science in order for them to remain interested in studying science in school and beyond. To the best of my knowledge, there are no reported studies carried out in the areas of science learning environments, attitudes towards science and cooperative learning in science classes in the UAE. This study is significant to the field of learning environments as well as science education because it is the first study of its kind to examine the impact of cooperative learning on students' perceptions of the learning environment and their outcomes in science classes in Abu Dhabi, UAE. This section provides a brief overview of the significance of this study to the relevant stakeholders, discussed below.

This study has extended the field of research into learning environments, as it is one of the first studies of its kind to examine the impact of cooperative learning in science classes on a range of student outcomes (attitudes, motivation, engagement

and science career aspirations) in Abu Dhabi, UAE. Specifically, this study has contributed to the literature on gender differences in terms of the impact cooperative learning in science has on attitudes, motivation and engagement in science and science career aspirations of students.

Methodologically, this study could be of significance to other researchers who might benefit from the availability of an Arabic version of the modified WIHIC for use in other studies. Also, the study makes accessible a reliable survey, available in both English and Arabic, to assess students' attitudes towards cooperative learning. This study contributes the development and validation of a survey to measure student attitudes. The instrument overcomes many of the problems of previous attitude surveys and can be translated, modified and used in many subjects. Furthermore, other researchers can also build on the findings of this research study and apply these to their own research.

It is likely that the findings of this study will be of significance to students, for whom the introduction of cooperative learning is likely to promote improved attitudes towards learning science in an environment where they can collaborate with their peers and improve their thinking, problem solving and social skills. This study is also significant to both teachers and education advisors in Abu Dhabi as its findings could provide teachers with the impetus to refocus and improve their teaching practices. Teachers are more likely to contribute to improving student attitudes towards science if they have a good understanding of what encourages this.

It is anticipated that the findings of this study will be of significance to school administrators, policy makers and educational organisations. The findings could assist these stakeholders in deciding whether cooperative learning should be implemented in science and extended to other subject areas. Policy makers and organisations such as ADEC can use these findings as a basis to drive future decisions associated with policies in education as well as strategies for teaching and learning and associated intervention programs.

1.6 Thesis Overview

The overarching aim of this study was to examine the impact of cooperative learning on students' perceptions of the learning environment and their outcomes (attitudes, motivation, engagement and aspirations) in science classes in Abu Dhabi, UAE. To address the aims, this thesis has been organised into six chapters, outlined below.

Chapter 1 highlights the context in which this study was undertaken, providing a detailed explanation of the history and background of the UAE. There is particular focus on the educational reform currently underway in Abu Dhabi, UAE, and the teaching and learning approach to cooperative learning as implemented in public schools across the Emirate. More specifically, the focus is on the benefits and positive aspects of implementing the cooperative learning approach, as reported in previous studies. The chapter outlines the conceptual framework section, including the paradigms and design which have formed the foundations of this study. The five research questions under investigation are delineated and the significance of the study to the relevant stakeholders is outlined.

Chapter 2 reviews the literature pertinent to the aims of this research study, beginning with an explanation of cooperative learning and its effectiveness in terms of teaching and learning. Following this, there is a review of the literature related to past research studies on students' attitudes towards science. Eight existing attitude surveys used in past studies to assess students' attitudes are reviewed, emphasising the need for the development and validation of an instrument to assess students' attitudes towards science. Next, gender differences in attitudes toward science are examined and include a review of studies which have investigated the variables which may affect students' attitudes towards science. Subsequently, literature associated with the field of learning environments is reviewed, with respect to the history of the field, range of instruments for assessing students' perceptions of the classroom environment and research within the field of learning environments. Importantly, the gaps in the literature in terms of student attitudes and the learning environment are clarified, and the ways in which this study contributes to the wider field are indicated where appropriate.

Chapter 3 provides a detailed description of the research methods employed in this study. The five research questions developed to address the overall aim are reiterated. The samples for the collection of both quantitative and qualitative data sets are described in detail, including the schools, teachers, classes and students. The data collection methods are presented, including a description of the two instruments used for the collection of quantitative data, and the teacher journal, classroom observations, interviews, lesson plans, and researcher journal used to gather the qualitative information. The data analysis methods are explained in detail, including the procedures for the validation of the questionnaires using the framework for construct validity (Trochim & Donnelly, 2006). This is followed by descriptions of the types of analysis used to answer each of the research questions. Finally, the ethical issues are described, detailing the ways in which they were addressed in terms of informed consent, voluntary involvement, confidentiality and considerations.

Chapter 4 reports the results for the quantitative data analysis. Evidence is provided to support the reliability of the two questionnaires in terms of their face and construct validity. The results and subsequent data analysis are presented to determine whether any relationships exist between students who are exposed to effective cooperative learning strategies and those who are not in terms of the learning environment, attitudes, motivation and engagement in science and science-related aspirations. Finally, the chapter reports the results of the data analysis used to determine whether cooperative learning was differentially effective for male and female students.

Chapter 5 presents the results and data analyses for the qualitative data collected from the seven case study teachers, including classroom observations, teacher journal and teacher interviews. There were four recurring themes which emerged once the data was analysed: increased cooperation, reduced behaviour problems, ability to cater for students of differing abilities, and assessment and resources.

The concluding chapter, Chapter 6, summarises and discusses the results of the study. This chapter links the findings of this study to the theoretical literature and other research findings. The limitations of the study are outlined and recommendations are suggested as to the measures which could be instigated to minimise their effects in future studies. The significance of the study is highlighted

in terms of its contributions to other researchers and various other stakeholders who can benefit from the findings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the literature pertinent to the aims of this study, which examines students' perceptions of the learning environment and their outcomes in science classes that incorporated cooperative learning in Abu Dhabi. The review is presented under the following headings:

- Cooperative learning (Section 2.2);
- Students' attitudes to science (Section 2.3);
- Gender differences in science (Section 2.4);
- History of the field of learning environments (Section 2.5); and
- Chapter summary (Section 2.6).

2.2 Cooperative Learning

The review of literature indicated that cooperative teamwork was introduced into science classrooms and laboratories in the late 1970s to enhance academic achievement and scientific literacy (Denrell, 2005). Cooperative, small-group learning has since been widely recognised as a teaching strategy that promotes learning and socialisation (Cohen, 1994). In cooperative learning, the classroom is structured into teams of learners in which students work together to accomplish shared goals (Lazarowitz & Hertz-Lazarowitz, 1998; Levitt, 2002; Lin, 2006; Treagust, 2007). It is this focus that helps students to develop a sense of 'group' as they recognise the need to help and support each other's learning and understanding (Gillies, 2002; Slavin, 1995). When students work cooperatively, they learn to give and receive help, share ideas, listen to other students' perspectives, seek new ways of clarifying differences, resolve problems, and construct new understandings from

engaging in these processes (Gillies, 2003b; Webb, Troper, & Fall, 1995). Additionally, cooperative learning is “a set of instructional strategies in which students work together in small groups to help each other learn academic content” (Slavin, 2010, p. 177).

Successful cooperative learning practices have several common characteristics. Johnson, Johnson and Holubec (2008) proposed the following five essential elements of cooperative learning.

Positive interdependence: The success of one learner is dependent on the success of the other learners and everyone must participate for the group to be successful.

Face-to-face (promotive) interaction: Students interact face-to-face and each individual can achieve promotive interaction by helping others, exchanging resources, challenging other’s conclusions, providing feedback, encouraging and striving for mutual benefits.

Individual accountability: Each student must be prepared to work in a group. Teachers should assess the amount of effort that each member is contributing. This can be achieved by giving an individual test to each student and randomly calling students to present their group’s work.

Interpersonal and small-group social skills: Students learn to listen and ask questions. Teachers must provide opportunities for group members to know each other, accept and support each other, communicate accurately and resolve differences constructively.

Group processing: Students discuss how well the group achieved its goal. Teachers must also provide opportunities for the class to assess group progress. Group processing enables the group to focus on good working relationships, facilitates the learning of cooperative skills and ensures that members receive feedback.

It is anticipated that students working cooperatively will perform at a higher academic level and will be more motivated to achieve than those working alone

(Johnson & Johnson, 1999). A simple path model of cooperative learning processes has been adapted from Slavin (1995), as depicted in Figure 2.1 which shows the path through which group goals may directly affect students' motivational behaviour, which, in turn, enhance cooperative learning outcomes. The diagram represents the main components of the group learning interaction, representing the functional relationship among the main theoretical approaches to cooperative learning. The path begins with a focus on group goals or incentives that are based on the individual learning of all group members. Thus, the model assumes that the motivation to learn, and to encourage and help others to learn, activates cooperative behaviours that result in learning, including both task motivation and motivation to interact in the group. Also, in this model, the motivation to succeed leads directly to learning, thereby driving the behaviours and attitudes which lead to group cohesion. This, in turn, facilitates the types of group interactions (peer modelling, cognitive elaboration and equilibration) and results in enhanced learning and academic achievement.

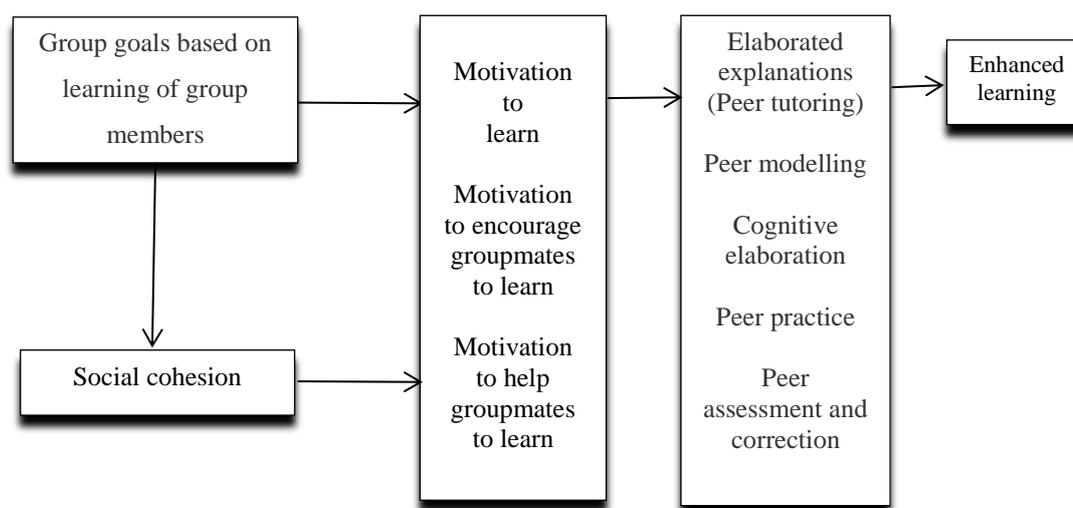


Figure 2.1 Effect of Group Goals on Students' Behaviour with Respect to Cooperative Learning Outcomes (modified from Slavin, 1995, p. 57)

Cooperative learning, as a learning and teaching strategy, has been introduced into many school subjects at various educational stages since it was initiated over 30 years ago (Johnson & Johnson, 1990; Kagan, 1994, 1995). Studies investigating the effects of cooperative learning report that students who work together in small groups learn better, build better relationships with peers and retain more information than those working alone (Bilgin, 2006; Bilgin & Geban, 2004; Kincal, Ergul, &

Timur, 2007; Senol, Bal, & Yildirim, 2007; Wachanga & Mwangi, 2004; Zacharias & Barton, 2004). Further, past research provides strong evidence to suggest that cooperative learning has a positive effect on students' attitudes towards science (Altinok & Acikgoz, 2006; Bilgin 2006; Bilgin & Geban, 2004; Bilgin & Karaduman, 2005; Doymus et al., 2004; George, 2005; Jones et. al., 2003).

Past research suggests that by working together toward a common goal, students develop more/better ideas and solutions, spend more time on tasks, transfer learning across areas and are (collectively) actively involved in the learning (Marks & O'Connor, 2013). A meta-analysis of over 1200 studies performed by Johnson and Johnson (1989, 1993) compared the performance of students educated using cooperative learning strategies with those educated using traditional methods such as lecturing. The results provided overwhelming evidence to suggest that cooperative learning was more likely to promote higher individual knowledge than was competitive or individualistic learning, irrespective of whether the tasks required mathematical, physical or verbal skills. Moreover, for students working cooperatively, the retention of knowledge was greater. Further, students working cooperatively gained more experience, developed better social skills, had more positive attitudes towards the subject matter, were more articulate and were more likely to respect differing viewpoints than students taught using traditional methods.

When compared with traditional instruction, past studies report gains from cooperative learning in science (Acar & Tarhan, 2008; Balfakih, 2003; Chang & Mao, 1999; Johnson, Johnson, & Taylor, 1993; Lonning, 1993; Lumpe & Staver, 1995; Winther & Volk, 1994). Past research also provides evidence to suggest that structured group roles work better than unstructured groups. When group roles are not assigned, spontaneously occurring roles fluctuate (Lumpe & Staver, 1995). Webb, Nemer, Chizhik, and Sugrue (1998) found that structured heterogeneous groups provided more benefit for below-average students than they disadvantaged high-ability students. Gillies (2003a, 2008) also investigated structured groups and found, not only gains in learning, but also changes in behaviour and the quality of discourse and interaction.

Researchers have also examined the development in self-confidence or self-esteem during cooperative learning, generally concluding that cooperative learning enhances students' self-esteem (Box & Little, 2003) and abilities to express their thoughts (Shachar & Sharan, 1994). Hanze and Berger (2007) found that cooperative learners felt more competent than traditional learners, particularly those with previous low self-concept. Lazarowitz, Hertz-Lazarowitz, and Baird (1994) found cooperative learning students scored higher on self-esteem, involvement in the classroom and number of friends, but not on social cohesiveness or cooperation. High-ability students, exposed to cooperative learning conditions, were found to demonstrate higher academic self-esteem and greater social cohesion (Johnson, Johnson, & Taylor, 1993).

Studies related to teachers' perceptions of cooperative learning strategies have also been reported (Al-Yaseen, 2011; Ferguson-Patrick, 2011). For example, a study by Gillies and Boyle (2010) reports on the perceptions of 10 middle-year teachers who implemented cooperative learning in their classrooms and spoke positively about their cooperative learning experiences. These researchers reported that the students responded well to their small-group experiences and that it helped them to better manage and structure lessons. Teachers reported the difficulties that they had experienced with cooperative learning, including concerns with the socialising that occurred in the groups, time management, and the organisation required to effectively implement cooperative learning. Another issue which challenged teachers was the type of task needed to motivate students and the composition of the group (gender, ability, friendship). All of the teachers agreed that for students to work successfully in groups, significant prior preparation was required, including training students in social skills and how to manage conflict. Additionally, assessing students in small groups presented a challenge for some teachers, some of whom resorted to making informal assessments of students' progress. Overall, the teachers reflected positively on their experiences of cooperative learning, but indicated that its implementation was a challenge and required commitment on the part of the teacher.

My review of literature indicates that there have been many studies into the effectiveness of implementing cooperative learning. To date, however, there has been a dearth of studies, in this domain, that have been undertaken in the Middle

East, a highly patriarchal culture that is very different to many of the countries in which the studies reported in this review were carried out. Therefore, my research will build on and extend this past research by examining the impact of cooperative learning in science classes on a range of student outcomes (attitudes, motivation, engagement and aspirations) in a Middle Eastern context.

2.3 Students' Attitudes to Science

The following section defines attitudes (Section 2.3.1), provides a review of literature related to past research on students' attitudes towards science (Section 2.3.2), and examines a number of surveys used in past studies to assess students' attitudes (Section 2.3.3).

2.3.1 Defining Attitudes

Attitude is a difficult concept to define, as it cannot be directly observed. This has resulted in a variety of definitions. For example, Chave (1928) defined attitude as a complex mixture of feelings, desires, fears, convictions, prejudices, or other tendencies. Attitudes were defined by Fishbein and Ajzen (1975) as learned predispositions to respond in a consistently favourable or unfavourable manner to a given subject.

Shrigley (1983) reviewed the socio-psychological literature in order to define attitudes, and identified five key elements that made up the concept of attitudes: attitudes are learned; attitudes predict behaviour; the social influence of others affects attitudes; attitudes are a readiness to respond; and attitudes are evaluative, with emotion involved. When we have an attitude about something we tend to judge it along emotional dimensions such as good or bad, harmful or beneficial, pleasant or unpleasant, important or unimportant. Thus, these evaluative judgements are always formed towards something, often called the *attitude object* (Crano & Prislin, 2006).

Past research indicates that students' attitudes will affect the choices that they make and may be acquired from a variety of sources (McCown et al., 1996). Social scientists have generally accepted the notion that attitudinal behaviour is learned and

can be modified. A common definition of attitude has implied that there are three components in the description of attitudes - cognition, affect and behaviour (Bagozzi & Burnkrant, 1979; McGuire, 1985; Rajecki, 1990). A clear definition of these components has been provided by Reid (2006): knowledge about the object, the beliefs, ideas component (cognitive); a feeling about the object, like or dislike component (affective); and a tendency-towards-action, the objective component (behavioural).

Some researchers have suggested that the three components should be treated independently and that attitudes should be viewed in a narrower way as the basis for evaluative judgements (Ajzen, 2001; Crano & Prislin, 2006). For the purpose of this study, Reid's (2006) tripartite view of attitudes, cited above, appears sensible, given the close link between the components. For instance, we know about science and thus have a feeling or an opinion about it that may cause us to take some actions (Kind, Jones, & Barmby, 2007).

Almost 40 years ago, concerns about attitudes to science were highlighted by Ormerod and Duckworth (1975, p. 150) when they commenced their review on the topic of students' attitudes to science, carried out in the UK, with the following statement:

‘In 1965 a thorough enquiry began into the flow of students of science and technology in higher education. The final report (Dainton, 1968) laid particular emphasis on the phenomenon which had become known as the ‘swing from science’. Several explanations were suggested for the swing, among them a lessening interest in science and disaffection with science and technology amongst students.’

Since then, evidence has suggested that this trend with respect to science has become worse over time and, as a result, this topic has been the subject of considerable investigation, both theoretically and empirically. So, although our understanding of this problem has improved, the remediation of the problem is yet to follow (Osborne, Simon & Collins, 2003).

The study reported in this thesis examines how the learning environment, created using effective cooperative learning strategies, impacts on students' attitudes towards science in Abu Dhabi, UAE.

2.3.2 *Past Research Related to Students' Attitudes*

Given the lack of standardised definitions and measurement instruments, findings in attitudes toward science research are difficult to compare. However, two general patterns have emerged from the literature. Firstly, over time, there is a steady decline in students' attitudes towards science, particularly emphasised in secondary schooling, as reported by George (2006) and Reid and Skryabina (2002). Secondly, differences have been found between the attitudes of males and females, with males being more positive and having a less negative trend in their development of attitudes than females (Barmby, Kind, & Jones, 2008). Upon careful examination, it would appear that students' attitudes toward school science have become more negative or less motivated, whilst attitudes towards real science and the usefulness of science remain stable (Osborne et al., 2003; Schibeci, 1984).

Past studies have examined changes in students' attitudes over time; however, the results of these studies differ considerably. Some studies have reported that students' attitudes towards science decline in their primary school years (Murphy & Beggs, 2001; Pell & Jarvis, 2001; Simpson & Oliver, 1985). Others, however, report that students' attitudes towards science do not decline in primary years (Harvey & Edwards, 1980; Yager & Yager, 1985). Further, studies have reported a decline in students' attitudes towards science in secondary years (or from primary to secondary) (George, 2006; Reid & Skyrabina, 2002; Yager, Simmons, & Penick, 1989). Others have found that students' attitudes towards science do not decline from primary to secondary level (Hobbs & Erickson, 1980).

These contradictory results in past research with respect to students' attitudes towards science could be due to: the nature of the attitudes themselves (that is, the studies have measured different attitudes); the contexts in which attitudes have been measured (that is, attitudes may develop differently in different contexts); or the

validity of the research instruments (the same attitudes have been measured but some instruments have poor validity). Schreiner and Sjøberg (2007) focus on students' 'identity construction' which, they report, plays a strong role in the way young people relate to science in western societies today as opposed to the past. This tells us that the results of past research are not only difficult to transfer from one time period to another but from one society to another. Students' attitudes must be regarded as a characteristic of the context in which the research has been conducted (Barmby, et al., 2008). It is, therefore, not easy to make simple conclusions. The next section provides an overview of previous instruments used to assess students' attitudes.

2.3.3 Assessing Attitudes

Numerous instruments have been developed to measure students' attitudes towards science, but with two serious constraints (Kind et al., 2007). Firstly, the concept of attitudes is often poorly articulated and not well understood (Osborne et al., 2003); and secondly, it is common for attitude measures to have poor psychometric qualities (Gardner, 1995, 1996; Munby, 1997). It seems that the problem results from a tradition for measuring attitudes that is somewhat "pragmatic" and does not take into account the difficulty of understanding a complicated psychological construct (Kind et al., 2007). It is difficult to compare the findings in attitudes towards science research across studies because of the lack of standardised definitions and measurement instruments (Barmby et al., 2008).

The well-cited work of Munby (1983, 1997) and Osborne et al. (2003) were drawn on by Kind et al. (2007) to identify a number of well-known, important and long-standing problems related to many of the attitude scales developed in the past. Some of these problems include:

- The combining of conceptually-different constructs to form one unidimensional scale;
- The lack of clarity in the descriptions of the constructs to be measured;
- Failure to address construct validity; and

- Low reliability of the measurement.

Thus, the decision to develop a new instrument, rather than use an existing instrument, was made after a review of widely-published attitude instruments and in light of the research aim. Over 65 attitude instruments were examined during this review of literature. The majority of these instruments included the problems outlined by Kind et al. (2007). Although some instruments were theoretically sound and evidence was provided to support the psychometric properties, these did not include all of the constructs required for the present study. This section evaluates a handful of the attitude instruments that were reviewed, including: Attitude Toward Science Scale (Section 2.3.3.1); Scientific Attitude Inventory (Section 2.3.3.2); Attitude Toward Science in School Assessment (Section 2.3.3.3); Colorado Learning Attitudes about Science Survey (Section 2.3.3.4); Dimensions of Attitude toward Science Instrument (Section 2.3.3.5); Test of Science-Related Attitudes (Section 2.3.3.6); Attitude Towards Chemistry Lessons Scale (Section 2.3.3.7); and the Student Adaptive Learning Engagement Survey (Section 2.3.3.8).

2.3.3.1 *Attitudes Toward Science Scale (ATS)*

The Attitudes Toward Science (ATS) scale, developed by Francis and Greer (1999), has a total of 20 items that are arranged randomly. They include both positively and negatively worded items and are responded to using a four-point Likert-type scale that ranges from strongly disagree to strongly agree. The 20 items were selected from an original batch of 62 science-related questions, with sample items such as: ‘I very much look forward to science lessons and activities in school’ and ‘Science is very important to the future of the US.’

Some studies have reported that the scale operationalised the affective attitudinal domain (Francis & Greer, 1999; Liaghatdar, Soltani, & Abedi, 2011). However, Smith, Walker, and Hamidova (2012) argue that it is not a uni-dimensional structure but rather, a multi-dimensional composition. Close examination of the items suggests that many of them expressed both belief and attitudinal statements. Given the uncertain reliability of this instrument, it was not considered to be suitable for use in this study.

2.3.3.2 *Scientific Attitude Inventory (SAI)*

The Scientific Attitude Inventory (SAI) was developed by Moore and Sutman (1970) to assess high school students' scientific attitudes. The SAI includes six areas of attitudes towards science: the nature of the laws/theories of science; the basis of scientific explanation; characteristics needed to operate in a scientific manner; the type of activity engendered in science; progress in science; and science as a career. The first six position statements emphasise intellectual attitudes and the last six position statements emphasise emotional attitudes. Each position statement consists of positive and corresponding negative attitudes with respect to science, with each statement intended to be the opposite of the other. The survey includes 60 items, each of which is responded to using a four-point Likert-type scale of strongly agree, mildly agree, mildly disagree and strongly disagree. Sample items include: 'Scientific explanations can be made only by scientists' and 'I do not want to be a scientist because it takes too much education.' The SAI was field-tested by Moore and Sutman (1970) with three groups of tenth grade biology students to examine its construct validity and reliability.

Lichtenstein et al. (2008) re-evaluated the psychometric properties of a revised form of the SAI, named the SAI-II, with a sample of 543 middle and high school students in four schools in Texas. Factor analysis failed to support the existence of a six-factor structure (as proposed by Moore and Sutman, 1970). Exploratory and confirmatory models yielded a tree-factor solution that did not fit their data well. Additionally, in the sample employed by Lichtenstein et al. (2008), the SAI-II did not have satisfactory psychometric properties and was not recommended for further use. Additionally, Baker (1985) employed the SAI and found that this instrument was not valid for measuring attitudes toward science in school but was measuring some other construct. Given these findings and that the constructs assessed in this scale were not pertinent to the present study, the SAI was not considered for use.

2.3.3.3 *Attitude Toward Science in School Assessment (ATSSA)*

The Attitude Toward Science in School Assessment (ATSSA), developed and validated by Germann (1988), comprises 14 statements, approximately half of which

are negatively phrased. Many of the statements are drawn from existing instruments and used to assess attitudes in other subjects, using a five-point Likert scale of strongly agree, agree, neither agree nor disagree, disagree, strongly disagree. Two examples of items are: 'Science is interesting to me and I enjoy it' and 'Science is boring.'

A pilot test involving 125 science students was used to establish the factor structure. The ATSSA was found to be a valid and reliable instrument that was useful in examining relationships between variables that affect achievement and attitude (Germann, 1988). The ATSSA, when used by Houtz (1995), revealed significant differences in science attitudes in the seventh-grade sample but no change in attitude in the eighth-grade sample, and no significant differences in attitude were found between males and females, or students of different ability or socioeconomic groups. Since achievement and assessment were not related to the aim of the present study, the ATSSA was not considered useful for the present study.

2.3.3.4 *Colorado Learning Attitudes about Science Survey (CLASS)*

The Colorado Learning Attitudes about Science Survey (CLASS) was developed by Adams, Perkins, Podolefsky, Dubson, Finkelstein, and Wieman (2006). The CLASS examines students' beliefs about physics and learning physics and distinguished the beliefs of novices from those of experts. The CLASS contains 42 statements in eight scales related to student beliefs: real world connection; personal interest; sense making/effort; conceptual connections; applied conceptual understanding; problem solving general; problem solving confidence; and problem solving sophistication. Items are randomly ordered and responded to using a five-point Likert scale (strongly agree to strongly disagree). Two sample statements include: 'I study physics to learn knowledge that will be useful in my life outside of school' and 'After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic.'

Modified versions of the CLASS have been found useful for assessing students' beliefs about physics (Adams, et al., 2006; Zwickl, Finkelstein, & Lewandowski, 2012), chemistry (Barbera, Adams, Wieman, & Perkins, 2008) and biology (Semsar,

Knight, Birol, & Smith, 2011). Although found reliable in these past studies, many of the items were found to be complex and better suited to a specific science strand, rather than general science; therefore the CLASS was not considered for use in the present study.

2.3.3.5 *Dimensions of Attitude Toward Science (DAS)*

The Dimensions of Attitude toward Science (DAS) instrument was developed by van Aalderen-Smeets and van der Molen (2013) to assess the attitudes of in-service and pre-service primary school teachers towards teaching science. The DAS includes 28 items in three scales: cognition, affect, and perceived control. Within these dimensions there are seven sub-scales representing different thoughts, beliefs and feelings towards teaching science. Two sample items on the DAS are: ‘I have enough knowledge of the content of science to teach these subjects well in primary school’ and ‘I think that science education is essential for primary school children’s development.’ Items are responded to using a five-point scale, ranging from totally agree (score 5) to totally disagree (score 1). The items are ordered according to the sub-scale they fit under. Despite strong support for the construct validity of the DAS, it was developed for use with teachers, rather than students (the target population for the quantitative component of the present study), therefore it was not suitable for use in this study.

2.3.3.6 *Test of Science-Related Attitudes (TOSRA)*

The Test of Science-Related Attitudes (TOSRA) was developed by Fraser in 1981. The instrument was originally made up of five attitude scales with each scale having ten items. Improvements and extensions were subsequently made to the original TOSRA to support Klopfer’s (1971) rationale of science attitudes, namely: social implications of science; normality of scientists; attitudes towards science enquiry; adoption of scientific attitudes; enjoyment of science lessons; leisure interest in science; and career interest in science. Two sample items include: ‘I would prefer to find out why something happens by doing an experiment than by being told’ and ‘Public money spent on science in the last few years has been used wisely.’ Items were responded to using a five-point Likert scale of strongly agree, agree, not sure,

disagree and strongly disagree (Fraser, 1981). The statements on the TOSRA scales are moderately negative or positive, and include a balance of negative and positive statements in each of the seven scales.

The TOSRA has been used extensively and cross-validated in a range of studies (Fraser, Aldridge, & Adolphe, 2010; Haladyna & Shaughnessy, 1982; Schibeci & McGraw, 1981; Shrigley, 1983; Telli, den Brok, & Cakiroglu, 2010). The TOSRA overcomes many of the problems of past instruments used to assess attitudes, as it: defines each of the constructs to be measured by presenting distinct subscales based on Klopfer's (1971) classification of students' attitudinal aims; does not combine conceptually different constructs to form one scale; reports strong evidence of psychometric quality when used in past studies; and demonstrates unidimensionality and independence through factor analysis (Fraser, Aldridge, & Adolphe, 2010).

Given the TOSRA's strong theoretical base, wide use in past research, and because it overcomes most of the problems addressed by Kind et al. (2007) and Munby (1997), the TOSRA was drawn on for the development of the new attitude instrument used in this study.

2.3.3.7 *Attitude Towards Chemistry Lessons Scale (ATCLS)*

The Attitude Towards Chemistry Lessons Scale (ATCLS) was adapted from the TOSRA by Cheung (2009). The ATCLS is a 12-item instrument with four dimensions, these being: liking for chemistry theory lessons; liking for chemistry laboratory work; evaluative beliefs about school chemistry; and behavioural tendencies to learn chemistry. Each dimension consisted of three items. Two sample items on the ATCLS are: 'When I am working in the chemistry lab, I feel I am doing something important'; and 'Chemistry is one of the most important subjects for people to study.' All 12 items of the ATCLS are positively worded and the items are responded to using a five-point Likert scale of strongly agree, agree, not sure, disagree and strongly disagree.

Although the ATCLS has been used and validated in Hong Kong, when results of the confirmatory factor analysis indicated that there was a good fit between the

hypothesised model and the data (Cheung, 2009) and in Turkey (Ayyildiz & Tarhan, 2013; Tarhan & Sesen, 2010), the questions were more relevant to chemistry than to general science.

2.3.3.8 *Student Adaptive Learning Engagement Survey (SALES)*

The Student Adaptive Learning Engagement in Science (SALES) survey, developed by Velayutham, Aldridge, and Fraser (2011), consists of four scales: self-efficacy, self-regulation, learning goal orientation, and task value. Two examples of items are: 'I am friendly to members of this class' and 'I give my opinions during class discussions.' All of the items are positively worded and are categorised under the corresponding scale. Response alternatives range from strongly disagree to strongly agree.

The development of the SALES involved identifying key determinants of students' motivation and self-regulation in science learning, based on theoretical and research underpinnings. Analysis of data collected from 1,360 students in 78 classes across grades eight, nine and ten indicate that the SALES has strong construct validity (in terms of discriminant, concurrent and predictive validity) when used with lower secondary students (Velayutham, Aldridge, & Fraser, 2011).

Scales from the SALES have been used to create the Motivation and Self-regulation towards Technology Learning (MSRTL) instrument to measure students' motivation and self-regulation toward technology learning (Liou & Kuo, 2014). The SALES has also been adapted and used in a variety of languages including Turkish (Yetisir & Ceylan, 2015) and Arabic (Al Zubaidi, Aldridge, & Khine, 2014). In all cases, the adapted versions of the SALES were found to be valid and reliable.

Having reviewed the existing attitude instruments, none were considered to encompass all the scales necessary to address the aims of the current study. Given the pertinence of the scales in SALES to the objectives of my study, it was drawn on for the development of the attitude survey used in the present study.

Given that many of the instruments reviewed were either problematic or not relevant for the purpose of my study, a new instrument was developed to address the research questions. Details related to the development of the new attitude instrument can be found in Chapter 3.

2.4 Gender Differences in Science

Even though a number of variables may affect students' attitudes towards science, the two most influential factors appear to be gender and the quality of the instruction that students experience early in their academic lives (Ebenezer & Zoller, 1993; Osborne, Simon, & Collins, 2003; Schibeci & Riley, 1986). Today, more women than in the past obtain degrees in science and engineering (Dean & Fleckenstein, 2007; Hill, Corbett, & St. Rose, 2010). Nevertheless, women still remain underrepresented in science, technology, engineering and mathematics (Hill et al., 2010).

Past research has reported that males have more positive attitudes towards science than females (Cannon & Simpson, 1985; Francis & Greer, 1999; Weinburgh, 1995). However, George (2006) and Simpson and Oliver (1985) claim that although males start off with more positive attitudes than females, males' attitudes decline faster. In contrast, other researchers have reported that females' attitudes decline faster (Doherty & Dawe, 1985; Hadden & Johnstone, 1983).

Past studies have reported that females tend to exhibit more negative attitudes towards science classes and a career in science than do males (George, 2006; Haladyna & Shaughnessy, 1982; Weinburgh, 1995). Additionally, female students' interest in science has been found to gradually decline as they move from middle school to high school (Hofstein & Welch, 1984). Some researchers have suggested that positive attitudes are essential for students to develop an interest in science (Gogolin & Swartz, 1992; Weinburgh, 1995).

Desy, Peterson and Brockman (2011) carried out a study which examined gender differences in science-related attitudes with a sample of 1299 students in grades 6 to 12 at six middle and high schools in Minnesota. Significant gender differences were

found among these students, whereby females reported more anxiety about science as well as less motivation in and enjoyment of science than males did. However, in spite of their unfavourable attitudes towards science, a large percentage of females expected to pursue a college major and subsequent career in the health sciences.

In the United Arab Emirates, Samulewicz, Vidican and Aswad (2012) identified the social, cultural and economic factors that draw UAE women students to science, technology and engineering and those that keep them away from pursuing careers in this field. They surveyed over 2,500 women enrolled in universities and found that the key factors that attract women to a career in science, technology and engineering include financial independence, the exalted social status associated with this field, plentiful work opportunities perceived in this arena in the region and the opportunity to engage in creative and challenging projects. However, the barriers that prevent UAE women from finding or even seeking employment in this field include misalignment between university programs and labour market demand, lack of awareness of what a job in science, technology and engineering entails, familial bias against working in mixed-gender environments and lack of women role models who could inform women students about opportunities in these fields.

Differences between females and males in science achievement levels, have been found to be of major concern. According to the 1995 Trends in International Mathematics and Science Study (TIMSS) report, fourth grade males performed better in science than females in about half of the participant countries, while eighth grade males performed better in science than females in most of the participant countries. These results indicate that, as the grade level increases, the science achievement gap between males and females also increases in favour of males (Mullis, Martin, Ruddock, O'Sullivan, Arora, & Eberber, 2005). Additionally, Cakiroglu (1999) and Keeves (1992) found that, with respect to science achievement, males performed better than females in all countries and that the achievement gap widens as the grade level increases.

Major variables in classroom structure (cooperative or competitive, student-centred or teacher-centred) have been found to be powerful determinants of student attitudes in general and will operate differently for males and females (Moffat, Pibum, Sidlik,

Baker, & Trammel, 1992). Of interest to this study are the findings of past research related to the introduction of cooperative learning and its effect on students' attitudes. Many researchers have found that when students are taught through a cooperative learning approach (compared with a conventional learning approach) there is an increase in student success and improved attitudes about the science lesson (Arslan, Bora, & Samanci, 2006; Demir, 2008; Demirici, 2010; Kincal, Ergul, & Timur, 2007; Korkut-Owen, Owen, & Ballestero, 2009). This study extends past research on gender differences in science by examining whether exposure to cooperative learning is differentially effective for male and female students in terms of their perceptions of the classroom learning environment and attitudes towards science.

2.5 Learning Environments

Students spend approximately 20,000 hours in the classroom by the time they graduate from university, which is why their reactions to their teaching and learning experiences are of considerable importance (Fraser, 2012). Further, research has found strong and consistent associations between the learning environment and a range of student outcomes, both cognitive and affective, indicating that learning environments play an important role in effective teaching and learning (Fraser, 1998b, 2001, 2012). Educational researchers have found strong relationships between the learning environment and academic outcomes, and it is now widely recognised that the learning environment plays an important role in improving the effectiveness of learning (Fraser, 1998b, 2001; UNESCO, 2012).

The classroom environment, also referred to as the climate, atmosphere and ambience, are important factors which influence student learning. In the past, researchers have developed questionnaires to assess students' perceptions of their classroom learning environment. Fraser (2012) explains that such questionnaires provide information about: whether students actively participate in class or sit and listen to the teacher; whether students cooperate and discuss with each other what they are learning or whether they work alone; whether the class is dominated by the teacher or is student centred; whether the teacher is supportive and approachable;

and whether the students have a say in the choice of teaching and assessment methods.

This section provides a review of literature related to: the history of the field of learning environments (Section 2.5.1); range of existing learning environment instruments used in past studies (Section 2.5.2); and past research within the field of learning environments (Section 2.5.3).

2.5.1 History of the Field of Learning Environments

The field of learning environments is situated in the discipline of psychology, and draws on the works of prominent theorists. In the 1930s, Lewin (1936) developed the initial formal studies applicable to the field of learning environments. His field theory acknowledged that the environment and its interaction with individuals' personal characteristics are strong determinants of human behaviour. The need for updated research strategies in which behaviour would be accepted as a relevant function to the individual and his or her environment was strongly encouraged by Lewin.

Lewin did not develop a theory of drive or need. However, Murray (1938), a psychologist, was attracted to the internal determinants of behaviour and believed in focusing only on the external determinants of behaviour. Murray's *needs-press* model sought to address Lewin's omission by including the situational variables found in the environment that account for a degree of behavioural difference. Murray (1938, p. 124) made a distinction between 'needs' and 'press'; he defined *needs* as '...a force (the physio-chemical nature of which is unknown) in the brain region...which organizes perception, apperception, intellection, conation, and action in such a way as to transform in a certain direction an existing, unsatisfying situation.' Murray further developed the concept of 'needs', coining the terms *latent needs* (not openly displayed) and *manifest needs* (observed in people's actions). *Press* was defined as 'a temporal gestalt of stimuli which usually appears in the guise of a threat of harm or promise of benefit to the organism' (Murray, 1938, p. 40), or in brief, the external influences on an individual's motivation.

Murray made a distinction between *alpha press* (the environment as observed by an external observer) and *beta press* (the environment as perceived by people themselves). Thus, Murray's needs-press model complemented Lewin's formula by depicting personality characteristics as goal oriented, and environmental characteristics as external (having either a positive or a negative relationship to the personality needs of an individual). Both Lewin and Murray are widely accredited with having established the groundwork for building significant research ideas pertaining to classroom learning environments.

Stern, Stein, and Bloom (1956) built on Murray's findings pertaining to beta press as either *private beta press* (an individual's view of his or her environment) or *consensual beta press* (the collective view of a group as a whole). Stern (1970) advanced the existing framework by simplifying Murray's conceptual definitions. According to Stern, 'needs' refers to organisational tendencies that appear to give unity and direction to a person's behaviour, and 'press' refers to the phenomenological world of the individual - the unique and inevitable private view that each person has of the events in which they participate (Stern, 1970).

Although researchers gave weighted consideration to the dynamics of learning environments, a systematic process for the enquiry into the interaction of students within formal classroom structures was not in place. One of the first researchers to attempt to categorise and observe interactions in the classroom using trained observers who recorded elements of interaction in the classroom was Withall (1949). Getzels and Thelen (1960) later created a framework for the analysis of classroom structures as a unique social system. Doyle (1979) proposed that a strong emphasis should be placed on inter-relationships and communications among all members of the classroom community when assessing classroom environments. Doyle's theory emphasised that while learning is a concealed process, it takes place in school within the multifaceted social world of the classroom (Desforges & Cockburn, 1987).

Eventually, it was determined that students' perceptions of a wide range of instructional and social cues relevant to their own learning can be acquired in one classroom lesson (Walberg & Anderson, 1972). Questioning students about their perceptions presents an advantage over observations of teachers in that it receives

input from a much larger sample and is based on many hours of pragmatic observations by students (Fraser & Walberg, 1991).

In the late 1960s, the first learning environments questionnaires were developed in the United States. Walberg (1968) created the Learning Environment Inventory (LEI) as part of the research and evaluation activities of Harvard University's Harvard Project Physics, a national curriculum development project to create a physics education program in the United States (Walberg & Anderson, 1968). Walberg's research demonstrated that classroom climate could be reliably and economically measured with the use of high inference measures. Thus, he confirmed that individual students' satisfaction with the climate of a classroom would enhance learning, verifying that climate variables were good predictors of student learning outcomes (Anderson & Walberg, 1974).

Concurrently, Moos (1979) began developing the first of his social climate scales which eventually resulted in the development of the Classroom Environment Scale (CES) (Moos, 1979; Moos & Trickett, 1987). The CES was based on research involving perceptual measures of a variety of human environments, including psychiatric hospitals, correctional facilities, university residences, and work milieus (Moos, 1974).

Moos (1979) also delineated three dimensions for categorising human environments:

- Personal Development Dimension (which assesses basic directions along which personal growth and self-enhancement tend to occur);
- Relationship Dimension (which identifies the nature and intensity of personal relationships within the environment and assesses the extent to which people are involved in the environment and support and help each other); and
- System Maintenance Change Dimension (which involves the extent to which the environment is orderly, with clear expectations, maintains control and is responsive to change).

Moos's dimensions still exist in the modification of current assessment instruments (Fraser, 1998b) and in the creation of new instruments that reflect modern educational trends (Taylor, Fraser, & Fisher, 1997).

The efforts of both Moos and Walberg have motivated many researchers to embark upon a variety of research programs globally (Fraser, 1994, 1998b). Hence, classroom learning environments research has grown significantly, including the continued development of other learning environment instruments (Fraser, 1986, 1994, 2012; Goh & Khine, 2002; Wubbels & Levy, 1993). Since these early beginnings, in the 1960s, the field of learning environments has undergone remarkable growth, diversification and internationalisation (Fraser, 1998a).

2.5.2 Range of Learning Environment Instruments

A striking feature of the field of learning environments is the availability of a variety of economical, valid and widely applicable questionnaires that have been developed and used for assessing students' perceptions of the classroom environment (Fraser, 1998b). These questionnaires have been used at various educational levels and have been translated into many languages for use in numerous countries. A well-constructed questionnaire permits the collection of reliable and relatively valid quantitative and qualitative data in a simple, cheap and timely manner (Anderson, 1998). Thus, it is imperative for the researcher to select the appropriate instrument, as the selection can lead to different interpretations if there are different levels of variability and disparity (Fraser, 2012). Table 2.1 summarises nine notable classroom environment instruments classified according to Moos's (1974) scheme for classifying human environments. Table 2.1 also shows: the name of each scale in each of the instruments; the level (primary, secondary, higher education) for which each instrument is suited; the number of items contained in each scale; and the classification of each scale according to one of three dimensions, namely, Relationship Dimension, Personal Development Dimension and System Maintenance and System Change Dimension.

Table 2.1 Overview of Scales Contained in Some Classroom Environment Instruments

Instrument	Level	Items per Scale	Scales Classified according to Moos's Scheme		
			Relationship Dimension	Personal Development Dimension	System Maintenance and Change Dimension
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favoritism Cliquesness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisation
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation	Order and Organisation Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Elementary	6–9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalisation Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualisation
Questionnaire on Teacher Interaction (QTI)	Secondary or Primary	8–10	Leadership Helpful/ Friendly Understanding Student Responsibility and Freedom Uncertain Dissatisfied Admonishing Strict		
Science Laboratory Environment Inventory (SLEI)	Upper Secondary or Higher Education	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Constructivist Learning Environment Survey (CLES)	Secondary	7	Personal Relevance Uncertainty	Critical Voice Shared Control Investigation	Student Negotiation
What Is Happening In this Class (WIHIC)	Secondary	8	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity

Adapted from Fraser (2012, p.1196) with permission

This section provides a brief description of these nine historically significant and contemporary instruments, namely: Learning Environment Inventory (Section 2.5.2.1); Classroom Environment Scale (Section 2.5.2.2); Individualised Classroom Environment Questionnaire (Section 2.5.2.3); My Class inventory (Section 2.5.2.4); College and University Classroom Environment Inventory (Section 2.5.2.5); Questionnaire on Teacher Interaction (Section 2.5.2.6); Science Laboratory Environment Inventory (Section 2.5.2.7); Constructivist Learning Environment Survey (Section 2.5.2.8); and What Is Happening In this Class (Section 2.5.2.9).

2.5.2.1 Learning Environment Inventory (LEI)

The learning Environment Inventory (LEI) was developed in the late 1960s through the work of Walberg and in conjunction with the evaluation and research associated with the Harvard project Physics (Walberg & Anderson, 1968). The final version of the LEI included a total of 105 statements with seven items in each of 15 scales: cohesiveness, friction, favouritism, cliqueness, satisfaction, apathy, speed, difficulty, competitiveness, diversity, formality, material environment, goal direction, disorganisation and democracy. The items were organised in a cyclic order and scoring direction was reversed for some of the items. The items were responded to in terms of strongly disagree, disagree, agree and strongly agree. Two examples of LEI items are: 'The pace of the class is rushed' (speed scale); and 'All students know each other very well' (cohesiveness scale).

Although the internal consistency reliability and discriminant validity of the LEI were reported by Fraser, Anderson and Walberg (1982), the factor structure of the LEI has not been established. Further, although some scales are still used, many are intended for traditional, teacher-centred classroom settings rather than the cooperative learning, student-centred setting.

2.5.2.2 Classroom Environment Scale (CES)

The Classroom Environment Scale (CES) was developed by Moos and Trickett in 1974, and consists of the following nine scales: involvement, affiliation, teacher support, task orientation, competition, order and organisation, rule clarity, teacher

control, and innovation. Each scale has 10 items that are responded to using a True-False format. The development of the CES was based on a comprehensive research programme involving perceptual measures of varied human environments such as prisons, psychiatric hospitals, work milieus and university residences (Moos, 1974). Typical items in the CES are: ‘There is a clear set of rules for students to follow’ (rule clarity scale); and ‘The teacher takes a personal interest in the students’ (teacher support scale).

Similar to the LEI, the majority of scales were designed to examine the learning environment of traditional classrooms, although some scales have been modified for use in contemporary learning environments. Although numerous researchers have reported the validity and reliability of the CES when evaluating classroom settings (Fisher & Fraser, 1983; Humphrey, 1984; Moos & Trickett, 1974; Trickett & Moos, 1973), the factor structure has not been established. Further, the CES has been criticised for its true-false response format and although some scales continue to be relevant, many are not suited to more student-centred classrooms.

2.5.2.3 *Individualised Classroom Environment Questionnaire (ICEQ)*

The development of the Individualised Classroom Environment Questionnaire (ICEQ) was guided by: extensive interviewing of teachers and secondary school students; the literature on individualised open and enquiry-based education; and reactions to draft versions sought from selected experts, teachers and junior high-school students (Rentoul & Fraser, 1979). The final version of the ICEQ has a total of 50 items with 10 items in each of five scales, namely: personalisation, participation, independence, investigation and differentiation (Fraser & Butts, 1982). Items are responded to using a five-point frequency scale of almost never, seldom, sometimes, often and very often. Two sample items from the ICEQ are: ‘Different students use different books, equipment and materials’ (differentiation scale) and ‘The teacher considers students’ feelings’ (personalisation scale).

Burden and Fraser (1993) provide support for the cross-national validity of the ICEQ in a British study. Additionally, many researchers have utilised and validated the ICEQ in various classroom settings (Ashgar & Fraser, 1995; Fraser & Butts, 1982;

Fraser, Pearse, & Azmi, 1982; Yates, 2011). The ICEQ was not employed in this study because it was not considered to be a robust instrument when translated and used in non-Western contexts.

2.5.2.4 *My Class Inventory (MCI)*

The LEI was simplified to form the My Class Inventory (MCI) (Fisher & Fraser, 1981; Fraser, Anderson, & Walberg, 1982). The MCI was simplified further by Fraser and O'Brien (1985) to form a 25-item version. The MCI is intended for use with eight to twelve year old students by ensuring low reading levels of the items and the simple Yes-No response format. The MCI consists of five scales, namely, cohesiveness, friction, satisfaction, difficulty and competitiveness. Two sample items are: 'Children seem to like the class' and 'Children are always fighting with each other.' The items are arranged in blocks of five and in a cyclic order. Additional modifications have been made to the MCI. For example, to overcome the shortcomings of the yes-no format, Goh, Young, and Fraser (1995) created a three-point response format (seldom, sometimes and most of the time).

Although past studies have provided some evidence for the reliability of the MCI (for example, Majeed, Fraser, & Aldridge, 2002; Scott Houston, Fraser, & Ledbetter, 2008; Sink and Spencer, 2005), the MCI has been criticised for the inclusion of satisfaction as part of the learning environment when this has been viewed as a student outcome. Further, the use of the yes-no response format has been viewed as problematic, as this forces a response. Given this, and the age of the students it was intended for, the MCI was not considered for use in this study.

2.5.2.5 *College and University Classroom Environment Inventory (CUCEI)*

The College and University Classroom Environment Inventory (CUCEI) was developed by Fraser and Treagust (1986) for use in small groups of up to 30 students in higher education classes. The CUCEI captured the salient features of surveys developed for use with high school students, including the LEI, CES and ICEQ, which catered to students at the higher education level. The CUCEI includes seven

seven-item scales: personalisation, involvement, student cohesiveness, satisfaction, task orientation, innovation and individualisation. Items were responded to using the four response alternatives of: strongly agree, agree, disagree and strongly disagree, and the polarity is reversed for approximately half of the items. Two examples of items on the CUCEI are: ‘Teaching approaches allow students to proceed at their own pace’ (individualisation scale); and ‘Activities in this class are clearly and carefully planned’ (task orientation scale).

Although the CUCEI has been widely used and validated by a number of researchers (for example Fraser, Williamson, & Tobin, 1987; Joiner, Malone, & Haines, 2002), a modified version of the CUCEI used by Logan, Crump, and Rennie (2006) in two independent studies found that the statistical performance of the CUCEI was not completely satisfactory in either study. Their findings revealed a number of problems common to both studies: students did not understand the meaning of some items; students were annoyed at the similarity of item statements; and some students complained about the amount of time it took to complete each version (15-20 minutes). Overall, Logan, Crump, and Rennie (2006) reported that the CUCEI did not prove to be as reliable and valid as had been expected from previous reports. As this study was carried out in high schools, the CUCEI (designed for use in higher education) was not considered to be relevant.

2.5.2.6 *Questionnaire on Teacher Interaction (QTI)*

The Questionnaire on Teacher Interaction (QTI) drew on Leary’s (1957) theoretical model of proximity (cooperation-opposition) and influence (dominance-submission) to assess student perceptions of the teachers’ interpersonal behaviour. The development of the QTI was based on research that centred on the nature and quality of interpersonal relationships between students and teachers (Wubbles & Brekelmans, 2005; Wubbles, Brekelmans, & Hooymayers, 1991; Wubbles & Levy, 1993). The QTI consists of eight scales, namely: leadership, helpful/friendly, understanding, student responsibility and freedom, uncertain, dissatisfied, admonishing and strict. Each item is responded to using a five-point response scale ranging from never to always. Two items which appear on the QTI are: ‘The teacher

gets angry' (admonishing behaviour) and 'The teacher gives us a lot of free time' (student responsibility and freedom behaviour).

Numerous studies have cross validated the QTI and comparative work has been carried out in: Australia (Fisher, Henderson, & Fraser, 1995; Stolarchuk & Fisher, 2001); Singapore (Goh & Fraser, 1996); the USA (Wubbles & Levy, 1993); Brunei Darussalam (Scott & Fisher, 2004); Korea (Kim, Fisher, & Fraser, 2000; Lee, Fraser & Fisher, 2003); and Indonesia (Fraser, Aldridge, & Soerjaningsih, 2010). Even though the QTI has been used extensively in past research, this instrument only assesses student-teacher interpersonal relationships and therefore was not considered for use in this study.

2.5.2.7 *Science Laboratory Environment Inventory (SLEI)*

The Science Laboratory Environment Inventory (SLEI) was developed by Fraser, Giddings, & McRobbie (1995) to assess the environment of science laboratory classes in senior high schools and institutions of higher education. The SLEI has five scales, namely, student cohesiveness, open-endedness, investigation, rule clarity and material environment. Each scale has seven items, providing a total of 35 items. The items are responded to using a five-point format of almost never, seldom, sometimes, often and very often. Two items on the SLEI were: 'We know the results that we are supposed to get before we commence a laboratory activity' (open-endedness) and 'I would get on well with students in this laboratory class' (student cohesiveness).

The SLEI was originally field tested and validated simultaneously in 71 laboratory classes in six countries: Australia, Canada, England, Israel, Nigeria and the USA (Fraser, Giddings, & McRobbie, 1992). The SLEI has since been cross-validated and used to assess science laboratory classes in many countries around the world (Fraser & McRobbie, 1995; Henderson, Fisher, & Fraser, 2000; Quek, Wong, & Fraser, 2005; Wong & Fraser, 1996). Even though the study reported in this thesis examines science classrooms, it is not related specifically to the laboratory setting, therefore the SLEI was not considered suitable.

2.5.2.8 *Constructivist Learning Environment Survey (CLES)*

The Constructivist Learning Environment Survey (CLES) was developed by Taylor, Fraser, and Fisher (1997) to assess the extent to which a classroom's environment is consistent with a constructivist epistemology. The CLES includes five scales: personal relevance, uncertainty, critical voice, shared control, and student negotiation. Each scale includes seven items per scale that are responded to using a five-point frequency scale of: almost never, seldom, sometimes, often, and almost always. Two items on the CLES are: 'I get the chance to talk to other students' (student negotiation); and 'I learn interesting things about the world outside of the classroom' (personal relevance).

Although the CLES has been cross-validated in Australia and Taiwan (Aldridge, Fraser, Taylor, & Chen, 2000), the USA (Nix, Fraser, & Ledbetter, 2005), Korea (Kim, Fisher, & Fraser, 1999), New Zealand (Taylor, 2012) and South Africa (Aldridge, Fraser, & Sebela, 2004), the present study does not examine these specific elements of constructivism. Therefore, this instrument was not considered.

2.5.2.9 *What Is Happening In this Class (WIHIC)*

The What Is Happening In this Class (WIHIC) questionnaire was originally developed by Fraser, Fisher, and McRobbie (1996) with 90 items in each of nine scales. The WIHIC combines customised versions of salient scales from a variety of existing questionnaires with additional scales which embrace contemporary educational concerns, such as constructivism and equity (Fraser, 2002). The original WIHIC was refined by Aldridge, Fraser, and Huang (1999) to include seven eight-item scales: student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, and equity. Items of the WIHIC are responded to using a five-point frequency scale of almost never, seldom, sometimes, often, and almost always. Two typical items on the WIHIC are: 'I cooperate with other students on class activities' (cooperation); and 'The teacher helps me when I have trouble with the work' (teacher support).

The WIHIC questionnaire is the most frequently-used classroom environment instrument and has been found to be reliable in many English-speaking countries around the world (Fraser, 2012). These countries include Australia (Dorman, 2008); Australia and Canada (Zandvliet & Fraser, 2004, 2005); Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008); India (Koul & Fisher, 2005, 2006); Uganda, Africa (Opolut-Okurut, 2010); New Zealand (Saunders & Fisher, 2006); South Africa (Aldridge, Fraser, & Ntuli, 2009) and the United States of America (den Brok, Fisher, Rickards, & Bull, 2006; Holding & Fraser, 2013; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; Pickett & Fraser, 2009; Wolf & Fraser, 2008).

The WIHIC has also been translated and validated into other languages, including Mandarin (Aldridge & Fraser, 2000); Korean (Kim, Fisher, & Fraser, 2000; Khine & Fisher, 2003), Bahasa Indonesian (Fraser, Aldridge, & Adolphe, 2010; Margianti, Fraser, & Aldridge, 2001; Wahyudi & Treagust, 2004); IsiZulu (Aldridge et al., 2009); Sepedi (Aldridge, Laugksch, Seopa, & Fraser, 2006); Arabic (Afari, Aldridge, Fraser, & Khine, 2013; MacLeod & Fraser, 2010); Spanish (Allen & Fraser, 2007; Robinson & Fraser, 2013); and Greek (Giallousi, Gialamas, Spyrellis, & Pavlaton, 2010).

In Australia, Canada and the UK, Dorman (2003) carried out a study with a sample of 3,980 high-school students, proving that the WIHIC was a valid measure of the classroom psychosocial environment. Confirmatory factor analysis supported the seven scale a-priori structure, including fit statistics that indicated a good fit of the model to the data. The three grouping variables of country, grade level and student gender substantiated invariant factor structures through the use of multi-sample analyses within structural equation modelling. Thus, Dorman's study supports the wide international applicability of the WIHIC as a valid and reliable measure of the classroom psychosocial environment (Fraser, 2012).

The WIHIC was selected for use in the present study because of its applicability for use in secondary science classrooms and its ability to provide a holistic picture of the actual psychosocial classroom learning environment. To ensure that the original WIHIC was suitable for use in high schools in the UAE, the instrument was adapted

in terms of scale selection and language, the details for which are provided in Chapter 3.

2.5.3 *Research within the Field of Learning Environments*

In the last four decades, researchers have drawn on learning environment questionnaires to carry out numerous studies worldwide (Aldridge & Fraser, 2008; Fraser, 2012). In a review of past learning environment studies, Fraser (2012) reports on a range of types of research that have been carried out in the field of learning environments, including: associations between student outcomes and environment; use of environment dimensions as criterion variables in the evaluation of educational innovations; teachers' practical attempts to improve their classroom and learning environments; differences between students' and teachers' perceptions of actual and preferred environment; combining quantitative and qualitative methods; school psychology; links between educational environments; cross-national studies; typologies of classroom environments; and transition between different levels of schooling. This section provides a detailed review of three of these lines of learning environment research that were pertinent to the aims of this study: associations between student outcomes and environment (Section 2.5.3.1); evaluation of educational innovations (Section 2.5.3.2); and combining quantitative and qualitative research methods (Section 2.5.3.3).

2.5.3.1 *Associations Between Student Outcomes and Environment*

Previous research on classroom environments has predominantly 'involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classrooms' (Fraser, 2012, p. 1218). Numerous past studies in science education have shown that associations between outcome measures and classroom environment perceptions have been replicated for various cognitive and affective outcome measures, various classroom environment instruments, and an array of samples (extending across many countries, subjects and grade levels). A range of studies that have reported associations between various student outcomes and perceptions of the classroom environment are summarised in Table 2.2.

Table 2.2 Sample Studies of Associations Between Student Outcomes and Classroom Learning Environment

Study	Outcome Measures	Sample
<i>Studies employing CES</i> Fisher & Fraser (1983)	Attitudes Enquiry Skills	116 grade 8 and 9 science classes in Tasmania, Australia
<i>Studies employing MCI</i> Goh, Young, & Fraser (1995)	Attitudes Achievement	1,512 grade 5 mathematics students in 39 classes in Singapore
Majeed, Fraser, & Aldridge (2002)	Attitudes	1,565 mathematics students in 81 classes in Brunei, Darussalam
<i>Studies employing QTI</i> Telli, den Brok, & Cakiroglu (2010)	Attitudes	7,484 grade 9-11 students from 278 classes in 13 cities in Turkey
<i>Studies employing SLEI</i> Fisher, Henderson, & Fraser (1997)	Attitudes	489 senior high school biology students in Australia
Wong & Fraser (1996)	Attitudes	1,592 grade 10 chemistry students in Singapore
<i>Studies employing CLES</i> Aldridge, Fraser, & Sebela (2004)	Attitudes	1,843 grade 4 to 9 students in 29 mathematics classes in South Africa
Nix, Fraser, & Ledbetter (2005)	Attitudes	1,079 high school students in 59 classes in Texas, USA
<i>Studies employing WIHIC</i> Afari et al. (2013)	Academic Efficacy Enjoyment	352 college-level mathematics students in 33 classes in the UAE
Okan (2008)	Attitudes	152 university students in Turkey
Opolut-Okurut (2010)	Motivation	81 secondary school students in 2 schools in Uganda
Velayutham, Aldridge, & Fraser (2011)	Motivation Self-regulation	1,360 grade 8 to 10 science students in Perth, Australia
Zandvliet & Fraser (2005)	Attitudes	1,404 students in 81 classes in Australia and Canada

Adapted from Fraser (2012) with permission

This section provides a review of literature pertinent to the field of learning environments and variables that are closely related to those included in the present study, namely, attitudes, motivation, efficacy and career choice.

Environment-Attitude Associations. Recent studies that have investigated associations between student attitudes and the learning environment include those by Kenar, Balci, and Gokalp (2013), Mink and Fraser (2005) and Teh and Fraser (1994). Researchers have also focussed on this area of research in many subject areas, including science (Aldridge et al., 1999; Aldridge & Fraser, 2000; Kerr, Fisher, Yaxley, & Fraser, 2006; Koul & Fisher, 2005; Lay & Khoo, 2012; Martin-Dunlop & Fraser, 2008; Peer & Fraser, 2015; Shadreck, 2012; Telli, Cakiroglu, & den Brok, 2006; Wolf & Fraser, 2008), mathematics (Afari et al., 2013; Ogbuehi & Fraser, 2007), mathematics and science (Fraser & Raaflaub, 2013) and geography and mathematics (Chionh & Fraser, 2009).

Findings strongly suggest that students have more positive attitudes towards the class or subject when they perceive their classroom learning environment as more positive (Dorman & Fraser, 2009). For example, Dorman and Fraser (2009) investigated student attitudes, classroom environment and antecedent variables (gender, grade level and home computer and internet access) with a sample of 4,146 high-school students. They reported that improving the classroom environment had the potential to improve student attitudes and that the antecedents did not have any direct effect on the outcomes. In Turkey, Telli, den Brok, and Cakiroglu (2010) administered the QTI to a sample of 7,484 students in grades 9 to 11 from 278 classes in 55 public schools. Multilevel analyses of variance indicated that the proximity dimension of the QTI was associated with attitudes to enquiry, and the influence dimension was related to student enjoyment. Overall, studies which have investigated the associations between the learning environment and student attitudes have generally found that improving the learning environment ultimately improves students' attitudes.

Environment-Motivation Associations. Many past studies have investigated the effect of the learning environment on student motivation. Environment-motivation outcomes have been investigated for various subjects, including science (Barak,

Ashkar, & Dori, 2011; Koul, Roy, & Lerdpornkulrat, 2012; Nolen, 2003; Velayutham & Aldridge, 2013) and mathematics (Gilbert, Musu-Gillette, Woolley, Karabenick, Strutchens, & Martin, 2014; Opolot-Okurut, 2010). A study by Velayutham and Aldridge (2013) sought to identify salient psychosocial features of the classroom environment that influence students' motivation and self-regulation in science learning. Using structural equation modelling involving 1,360 science students, their findings suggest that student cohesiveness, investigation and task orientation are the most influential predictors of student motivation and self-regulation. Similarly, Gilbert et al. (2014) examined the relationships between middle school students' ($N=979$) perceptions of their mathematics classroom environment and their motivation. Structural equation modelling indicated that motivational variables (utility, personal achievement goals, efficacy) mediate the influence of teacher support and use of reform practices on mathematics standardised test scores.

Koul, Roy, and Lerdpornkulrat (2012) investigated the relationships between students' perceptions of the classroom learning environment and motivational achievement goal orientations towards biology and physics ($N=1,538$). Their findings suggest that motivational goals are linked to differences in students' perceptions of the learning environment. Overall, their results suggest that motivational goal orientations and perceptions of learning environment are gender-dependent and domain-specific for the two science content areas in their study.

In Uganda, Opolot-Okurut (2010) examined whether students' perceptions of the mathematics classroom learning environment affected their motivation towards mathematics. The study, involving a sample of 81 secondary school students in two schools, found positive associations between students' perceptions of their mathematics classroom learning environment and motivation towards mathematics.

In summary, these studies, which investigate the associations between the learning environment and student motivation, have generally found that improving the learning environment is likely to enhance students' motivation.

Environment-Efficacy Associations. Past research in countries around the world has examined the impact of the learning environment on students' self-efficacy, including studies in: India (Gupta & Fisher, 2012); Canada (Ferguson & Dorman, 2001); the UAE (Afari et al., 2013); Australia and Britain (Dorman & Adams, 2004); and Australia (Dorman, 2001; Kerr et al., 2006; Velayutham, Aldridge, & Fraser, 2011). Generally, studies investigating this domain have reported strong and positive associations between students' perceptions of the learning environment and students' self-efficacy in relation to learning. For example, Gupta and Fisher (2012) examined the relationships between students' perceptions of their learning environment in technology-supported science classrooms and students' self-efficacy with a sample of 705 students in 15 classes. The results indicate that involvement, task orientation, investigation, differentiation and technology teaching scales are significant independent predictors of academic efficacy. Another study involving 2,651 mathematics students from Australian and British secondary schools found statistically significant correlations between the classroom environment and academic efficacy (Dorman & Adams, 2004). That is, enhanced classroom environments are associated with higher levels of student academic efficacy.

Ferguson and Dorman (2001) investigated the relationship between the classroom environment and academic efficacy for Canadian high school mathematics students, and established that unique and joint contributions of learning environment dimensions explain academic efficacy. The study indicates that a number of important classroom environment dimensions are associated significantly with academic efficacy. For example, improved levels of involvement, investigation and task orientation are associated with higher levels of academic efficacy.

In summary, studies that have examined the relationship between the learning environment and student motivation have found positive relationships between the two. That is, the more positively students perceive the learning environment, the higher their self-reports of self-efficacy and motivation.

Environment-Career Choice Associations. Associations between the learning environment and career choice have been widely investigated in a variety of settings. Investigations into environment-career associations include the use of virtual and

simulated teaching and learning environments to encourage students to choose Science, Technology, Engineering and Mathematics (STEM) careers (Dieker, Grillo, & Ramlakhan, 2012). Students who frequently worked out problems on their own and designed experiments or investigations have been found to express interest in a science career (House, 2009). Positive links between the learning environment, student motivations and mathematical career intentions have been found by Lazarides and Watt (2015). Also, Tseng, Chang, Lou, & Chen (2013) reported that combining problem-based learning with STEM can influence student attitudes in future career pursuits.

Positive links have also been found between student career aspirations and several variables of science education, including educational outcomes, instructional quality and home environment (Wang & Staver, 2001). Various factors of the school-level environment have been linked to student outcomes, including achievement, career aspirations and students' attitudes and beliefs about success in mathematics (Webster & Fisher, 2004). Overall, these studies have found that the learning environment (such as incorporating integrated or group learning) impacts positively on students' career choices. Past research has also found strong correlations between interest in a science career and the type of learning environment created. For example, interest in a science career is higher when student learning is related to their daily lives or involves them in designing their own experiments or investigations (House, 2009). Researchers have also examined whether learning using a project-based activity that integrates science, technology, engineering and mathematics influences students' future career aspirations (Tseng, Chang, Lou & Chen, 2013). Their findings suggest that knowledge of science is useful to their future careers and that combining a project-based learning activity influences student attitudes towards future career pursuits.

2.5.3.2 *Evaluation of Educational Innovations*

Classroom environment instruments have been used as a source of process criteria in the evaluation of educational innovations. This line of research evaluates the impact of innovations in changing or transforming the learning environment. The use of learning environment scales as an alternative to other student outcomes such as

achievement has been reported to provide a more detailed picture of the impact of innovation on students' educational process (Fraser, 2012). Learning environment instruments have been used as a source of process criteria in a variety of countries such as Korea (Fraser & Lee, 2009) and Singapore (Khoo & Fraser, 2008; Teh & Fraser, 1995), and subject areas, such as, mathematics (Afari et al., 2013) and science (Lightburn & Fraser, 2007; Wolf & Fraser, 2008). As examples, this section provides a brief review of four studies from different countries, namely, Singapore, the UAE and the US.

By incorporating a learning environment instrument into the evaluation of a science teacher development programme, Nix, Fraser, and Ledbetter (2005) examined whether students perceived their classrooms to be more constructivist. The results of the study, involving 445 students in 25 classes, suggested that, relative to the comparison classes, students of teachers who had undergone professional development perceived their classrooms as having higher levels of uncertainty and personal relevance.

In Singapore, Khoo and Fraser (2008) used a learning environment questionnaire to evaluate adult computer application courses using students' perceptions of the learning environments ($N=250$). Generally, they found that students perceived their computing classes as being relatively high in terms of involvement, task orientation, teacher support and equity compared with their usual learning environment. When these researchers investigated the differential effectiveness of computer courses for gender, they found that males perceived significantly greater involvement, trainer support and satisfaction, whereas females perceived significantly higher levels of equity in the computer classroom environment.

In the United Arab Emirates, Afari et al. (2013) investigated whether the introduction of games into college-level mathematics classes was effective in terms of improving students' perceptions of the learning environment and their attitudes towards mathematics. Their sample consisted of 352 students from 33 classes, of which eight classes (90 students) were exposed to mathematics games and the remainder were not. The findings indicated that those students exposed to mathematics games scored higher for teacher support, involvement, personal

relevance, enjoyment of mathematics lessons and academic efficacy scales than those who were not.

Many studies have also used learning environment perceptions as a source of process criteria. For example, in California, Ogbuehi and Fraser (2007) examined the effectiveness of using innovative teaching strategies in terms of classroom environment, attitudes to mathematics and mathematics achievement with a sample of 661 middle-school students in 22 classes. Their findings indicated that, compared with the control group, the group which experienced the innovative strategy perceived a more favourable learning environment, reported more positive attitudes and showed a greater degree of concept development in mathematics.

In another example, in New York, Wolf and Fraser (2008) used learning environment perceptions as part of their evaluation of the effectiveness of using enquiry-based laboratory activities ($N=165$). The results indicate that enquiry instruction promotes more student cohesiveness than non-enquiry instruction. Also, in California, Martin-Dunlop and Fraser (2008) used learning environment perceptions to help to evaluate an innovative science course for prospective elementary teachers. The results of their study, involving a sample of 525 females in 27 classes, showed large and statistically significant improvements for all scales after the introduction of the science course.

Although there is growing recognition of the usefulness of learning environment perceptions in evaluating educational innovations in that this set of variables provides a greater depth than achievement alone (Fraser, 2012), no such studies have been carried out in the UAE at the high school level. Therefore, this study extends the existing literature in this area, as it is the first of its kind in the UAE to use learning environment perceptions to examine the effectiveness of cooperative learning in the UAE as part of the reform efforts taking place.

2.5.3.3 *Combining Quantitative and Qualitative Research Methods*

Mixed methods research can be viewed as an approach which draws upon the strengths and perspectives of each method, recognising the existence and importance of reality and the influence of human experience (Johnson & Onquegbuzie, 2004). By using more than one method within a research program, it is possible to obtain a more complete picture of human behaviour and experience (Morse, 2003). Within the field of learning environments, considerable progress has been made in combining quantitative and qualitative methods within the same study (Creswell & Plano Clark, 2007; Fraser & Tobin, 1991; Tobin & Fraser, 1998).

In the field of learning environments, researchers have begun to demonstrate the benefits of combining qualitative and quantitative methods in learning environment research (Lee & Fraser, 2002). Table 2.3 outlines studies carried out within the field of learning environments that have involved a mixed-method approach. The table summarises the qualitative and quantitative approach used in each.

Junior high school students' conceptions of a constructivist learning environment were examined through an integration of both qualitative and quantitative approaches by Moustafa, Ben-Zvi-Assaraf, and Eshach (2013). Their sample consisted of 840 grade 8 and 9 students from over 15 junior high schools in Israel. The quantitative findings (involving the use of the CLES) indicated that a considerable portion of the students perceived their learning environment as a constructivist one and reported positive attitudes towards the way they were being taught. Students' reports and explanations also showed evidence that their learning experience was active, inquisitive, reciprocal and full of experiences. The qualitative findings (students' explanations) revealed the contrary to the quantitative findings; that some students did not perceive their learning environment as being constructivist.

Table 2.3 Studies Outlining the Types of Quantitative and Qualitative Data Collection Methods

Study	Type of quantitative data	Type of qualitative data
Akkus, Gunel & Hand (2007)	Pre-test/post-test, qualitative results quantified, and a national test	Interpretive case study data, observation and video recordings
Annetta, Mangrum, Holmes, Collazo & Cheng (2009)	Pre-test/post-test	Video recordings
Erdogan & Campbell (2008) BieriBuschor, Berweger, Keck Frei, & Kappler (2014) Markic & Eilks (2012)	Quantified qualitative data Questionnaires Surveys, re-interpretation of data subset	Video recordings Interviews Student teachers' drawings of themselves teaching Interviews, self-reflections and questionnaire
Jang (2006)		
Klosterman & Sadler (2010)	Self-developed test, expert validity and questionnaire Pre-test/post-test	Curriculum tests with open-ended questions
Luft (2009)	Quantified qualitative data	Interviews and observation
Parsons, Tran, & Gomillion (2008)	Existing ability tests	Video observation, existing observation instruments
Wheeler, Bell, & Whitworth (2015)	Observation forms	Surveys, interviews, observations and artefacts
Ritchie, Tomas, & Tones (2011)	Pre-test/post-test	Observation and interviewing
Kyei-Blankson (2014)	On-line survey	Interviews
Wu & Tsai (2007)	Quantified qualitative data	Open-ended questionnaire
Murcia (2008)	Questionnaire	Video recordings, questionnaires, interviews and sample writings
Ucar, Trundle, & Krissek (2011)	Multiple-choice assessment	Interviews
Castano (2008)	Self-validated survey, quantitative and qualitative data	Video recordings and open-ended questionnaire
Bell, Matkins, & Gansneder (2011)	Pre- and post-questionnaires and quantified qualitative data	Semi-structured interviews, assignments, open-ended questionnaire and electronic journal entries
Shanahan & Nieswandt (2011)	Survey developed and quantified qualitative data	Open-ended questionnaires and interviews

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A mixed-methods study investigating the field of learning environments was carried out by Aldridge, Fraser and Huang (1999). In this study, the qualitative data were collected from students in 50 classes in both Taiwan and Australia. Qualitative data were then collected using interviews and classroom observations. As well as identifying emergent themes, the researchers constructed narratives about what was happening in science classes in both Taiwan and Australia. Their qualitative data complemented their quantitative data and clarified any patterns and differences between the two countries.

In Australia, a multi-level study of the science learning environment was carried out by Fraser (1999), who incorporated a teacher-researcher perspective as well as the perspectives of six university-based researchers. The research began with an interpretive study of a tenth grade classroom at a school that provided a challenging learning environment. A mixed-methods approach was involved whereby several of the researchers visited the class each time they met over five weeks and took field notes, used student diaries, held team meetings and conducted interviews (teacher-researcher, students, school administrators, parents) using a video camera to gather the qualitative data. During and after each observation, field notes were written and team meetings took place three times per week over the five week period of study. The quantitative component consisted of the use of a questionnaire that connected three levels: selected classes within the school; the class in which the interpretive study was undertaken; and classes distributed throughout the same state. This permitted the researcher to pass judgement on whether the school was typical of other schools within the state and whether this teacher was typical of other teachers at her school.

Researchers such as Tobin and Fraser (1998) and Cresswell and Plano Clark (2007) have claimed that there are merits in moving beyond choosing qualitative *or* quantitative methods and combining both quantitative *and* qualitative methods. Thus, as a result of the desirable outcomes obtained in past studies from combining both methods, I have chosen to carry out my research using a mixed-method design to clarify reasons for patterns and differences in the data. Furthermore, the findings of this study will build on the existing findings of other studies in this line of research.

2.6 Chapter Summary

Science is important in many aspects of today's society, yet there appear to be fewer students electing science courses in high school and university, and fewer teachers interested in teaching science. If this is to change, it is essential for students to develop positive attitudes towards science so that they remain interested in studying the subject. Science teachers have the ability to foster the development of positive attitudes if they know what type of environment encourages positive attitudes. This chapter has reviewed literature relevant to the present study and related to cooperative learning, students' attitudes to science, gender differences in science and the field of learning environments.

Cooperative, small-group learning is widely recognised as a teaching strategy that promotes learning and socialisation (Cohen, 1994). When students work cooperatively, they learn to give and receive help, share ideas, listen to other students' perspectives, seek new ways of clarifying differences and resolving problems, and construct new understandings and learning from engaging in these processes (Webb, Troper, & Fall, 1995). Studies investigating the effects of cooperative learning report that students who work together in small groups learn better, build better relationships with peers and retain more information than those working alone (Bilgin, 2006; Bilgin & Geban, 2004; Kincal, Ergul, & Timur, 2007; Senol, Bal, & Yildirim, 2007; Wachanga & Mwangi, 2004; Zacharias & Barton, 2004). Although much past research has been carried out to examine the advantages of cooperative learning, there is little evidence to suggest whether these findings are relevant to a Middle Eastern setting. Therefore, the present study builds on the findings of past research by examining the implementation of cooperative learning in the UAE.

One of the most commonly discussed outcomes used in this past research is students' attitudes (Fraser, 2012). Attitude is a difficult concept to define, as it cannot be directly observed. However, many social and educational researchers have provided definitions of attitude dependent on the aims of their specific research studies. The definition of attitudes adopted in the present study is that attitudes are learned predispositions to respond in a consistently favourable or unfavourable

manner to a given subject (Fishbein & Ajzen, 1975). A review of the literature indicates that although a number of variables were found to impact on students' attitudes towards science, the two most influential appear to be gender and the quality of instruction students experience early in their academic lives (Ebenezer & Zoller, 1993; Osborne, Simon, & Collins, 2003; Schibeci & Riley, 1986). Today, more women than in the past obtain degrees in science and engineering (Dean & Fleckenstein, 2007; Hill, Corbett, & St. Rose, 2010). Nevertheless, women still remain underrepresented in science, technology, engineering and mathematics (Hill et al., 2010). Research suggests that males and females continue to differ in line with traditional gender stereotypes in terms of attitudes, self-efficacy, motivation and science career aspirations.

Based on a review of numerous past attitude instruments, a handful of which are described in this review of literature, no instrument was found that adequately addressed the needs of this study. Therefore, this study extends past studies by developing a measure that can be used in the UAE to assess student attitudes towards cooperative learning. In developing the attitude instrument, I sought to overcome the well-known and long-standing weaknesses related to many of the attitude scales developed in the past and identified by Kind, Jones, and Barmby (2007). The study reported in this thesis built on and extended past research by examining whether the use of cooperative learning impacts on students' attitudes and whether this impact was differentially effective for males and females.

Literature related to the field of learning environments, including the history and range of accessible questionnaires, has been reviewed in this chapter. The field of educational research is progressing rapidly and the myriad accessible and validated classroom environment questionnaires makes it possible for researchers worldwide to investigate the nature of learning environments in classrooms at all levels of education. A review of learning environment instruments indicated that the WIHIC survey was the most suitable to address the aims of this study. The present study drew on the field of learning environments. In particular, three types of learning environment research were examined, namely, associations between student outcomes and environment, evaluation of educational innovations, and combining quantitative and qualitative research methods. As there is a dearth of literature

related to the study of learning environments in the UAE, the study reported in this thesis built on and extended this past research. Further, the study fills a gap in past learning environment research by examining the impact of implementing cooperative learning on students' attitudes towards science in a Middle Eastern context.

This review of literature emphasises gaps in the existing literature and recognises the significance of the present study in bridging these gaps. This chapter provides the theoretical underpinning from which the aims of this study were generated. The next chapter provides a detailed description of the research methods employed in this study, including the research design, sample, data collection methods and ethical issues and considerations.

CHAPTER 3

RESEARCH METHODS

3.1 Introduction

The overarching aim of the proposed study is to examine the impact of cooperative learning on students' perceptions of the learning environment and their outcomes (attitudes, motivation, engagement and aspirations) in science classes in Abu Dhabi, United Arab Emirates. To address this aim, it was necessary to gather data in several ways. This chapter provides a detailed description of the research methods employed in this study, including the research design, sample, data collection and analysis methods, and the ethical issues, under the following headings:

- Research questions (Section 3.2);
- Research design (Section 3.3);
- Sample (Section 3.4);
- Collection of quantitative data (Section 3.5);
- Collection of qualitative data (Section 3.6);
- Data analysis (Section 3.7);
- Authenticity of qualitative data (Section 3.8);
- Ethical issues (Section 3.9); and
- Chapter summary (Section 3.10).

3.2 Research Questions

The five research questions which are the focus of the present study were introduced in Chapter 1 and are reiterated below.

Research Question #1

Are modified and translated versions of the What Is Happening In this Class (WIHIC) and Attitudes towards Cooperative Learning (ACL) instruments, which assess students' perceptions of the learning environment, attitudes, motivation, engagement and aspirations, valid and reliable when used in the UAE?

Research Question #2

What relationships exist between students' perceptions of a cooperative learning environment and their:

- a. Attitudes towards science;
- b. Motivation and engagement in science; and
- c. Science-related aspirations?

Research Question #3

Do differences exist for students in classes in which cooperative learning strategies are implemented effectively and those who are not, in terms of:

- a. Perceptions of the learning environment;
- b. Attitudes towards science;
- c. Motivation and engagement in science; and
- d. Science-related aspirations?

Research Question #4

Is exposure to cooperative learning differentially effective for male and female students in terms of their perceptions of the classroom learning environment and attitudes towards science?

Research Question #5

What are the benefits and challenges of implementing cooperative learning as part of the teaching and learning process?

3.3 Research Design

The study reported in this thesis employed a multistrand approach in which two interrelated studies were carried out sequentially. In this design, two relatively independent strands were utilised, in which the different research questions required the collection of quantitative data and qualitative information. A major advantage of this design was that it enabled me to ask both confirmatory (typically, but not always, quantitative) and exploratory (typically, but not always, qualitative) questions as well as verify and generate theory in the same study (Teddlie & Tashakkori, 2006). Further, it allowed me to draw on the strengths and non-overlapping weaknesses of both quantitative and qualitative methods (Teddlie & Tashakkori, 2006). Morse (2003, p. 189) explains that:

By combining and increasing the number of research strategies used within a particular project, we are able to broaden the dimensions and hence the scope of our project. By using more than one method within a research program, we are able to obtain a more complete picture of human behaviour and experience.

The study also involved the use of triangulation to enable the collection and analysis of data separately and independently for the purpose of enhancing the validity of the research findings (Creswell & Plano Clark, 2007). According to Miles and Huberman (1984, p. 235) ‘...triangulation is supposed to support a finding by showing that independent measures of it agree with it or, at least, don’t contradict it’ (Miles & Huberman, 1984, p. 235).

This research study was carried out sequentially in two phases, which can be represented by the notation:

QUAN → qual

This notation reflects a research design (referred to as an explanatory sequential design) in which quantitative methods were followed by qualitative methods, placing

more emphasis on the quantitative data (Creswell & Plano Clark, 2007). Firstly, a large-scale administration of two questionnaires was used to provide an indication of how students in Abu Dhabi, UAE perceived their learning environment, their attitudes, motivation, engagement towards science and their science career aspirations. Secondly, data from observations of science lessons, in-depth interviews with teachers, and journal entries kept by teachers were drawn on to explain the benefits and challenges of cooperative learning as a teaching and learning strategy.

3.4 Sample

This section describes the sample used in the present study, with a particular focus on the sampling techniques and the choice of sample (in terms of ensuring a representative population was chosen to allow for generalisation of the findings). The section first describes the sample used for quantitative data (Section 3.4.1), then goes on to describe the sample used for gathering qualitative information (Section 3.4.2).

3.4.1 Sample for the Collection of Quantitative Data

This section describes the sample used for the collection of the quantitative data, including: schools (described in Section 3.4.1.1); teachers (described in Section 3.4.1.2), classes and students (described in Section 3.4.1.3) and pilot study (described in Section 3.4.1.4).

3.4.1.1 Selection of Schools

The data was collected from students and teachers in eight public schools in Abu Dhabi, UAE. These schools were all middle schools, catering for students from grades 6 to 9 (known in Abu Dhabi as Cycle 2 schools) and aged between 12 and 15 years of age. All of the schools were required by the Abu Dhabi Education Council to implement the cooperative learning approach in science lessons (described in Chapter 1). As all of the schools were single sex, as required by the Abu Dhabi Education Council, four of the schools were all-female (taught by only female teachers) and four were all-male (taught only by male teachers). The four all-female schools were selected for convenience (as these were the schools in which I was

working) and the four all-male schools were selected to allow for age and gender comparisons.

All eight of the schools were situated on Abu Dhabi Island and were resourced by the Abu Dhabi Education Council. The schools catered for both Emirati (mostly) and expatriate (Arab) students. The schools were managed by Emirati principals and employed teachers from a range of nationalities. In the all-male schools many of the teachers were expatriates and, in the all-female schools, the teachers were mostly Emirati. This sample of schools was considered to be representative of public schools within the Abu Dhabi Emirate.

3.4.1.2 Selection of Teachers

All of the science teachers in each of the eight schools were invited to be involved in this research (all of whom accepted), providing a sample of 16 male science teachers and 17 female science teachers. Although there was some variation in the extent to which the teachers were implementing cooperative learning, as described in Chapter 1, all of the teachers had support from science education advisors to assist with the implementation. Students in the classes of these 33 science teachers participated in completing the two instruments (described in Sections 3.5.1.1 and 3.5.1.2) for the quantitative component of this study.

3.4.1.3 Selection of Classes and Students

A total of 34 science classes were included in the sample (16 classes from the all-male schools and 18 classes from the all-female schools). Four classes from each of the eight schools were selected (one class was randomly selected from each grade level). With the exception of one female teacher (who taught two grade levels), all of the teachers taught one grade level, therefore choosing a class from each grade level ensured that one class for each teacher was surveyed. As classes were not streamed, this sample provided a range of abilities and was considered to be representative of the Abu Dhabi public school population. A total of 784 students (365 of whom were male and 419 were female) from 34 classes were included in the quantitative sample.

Given the range of expertise among teachers, it was possible to classify these classes based on whether the teacher had an established understanding of cooperative learning or not. To identify which teachers had an established understanding, a range of criteria (discussed in the next Section, 3.4.2) was used. Of the total student sample, 494 students were not exposed to effective cooperative learning and 290 students were exposed to effective cooperative learning. In total, 22 classes were not exposed to effective cooperative learning and 12 classes were exposed to effective cooperative learning.

3.4.1.4 Sample for the Pilot Study

Both of the surveys used in the present study were pilot tested in one randomly selected all-female grade 7 class ($n=28$) to examine the readability and comprehensibility of individual items. Following the administration of the surveys for the pilot test, a focus group interview was held with six of the students. Selection of these students was based on their willingness to participate in the interviews.

3.4.2 Sample for the Collection of Qualitative Data

For the collection of qualitative data, the sample comprised the 17 female science teachers whose classes were involved in phase 1. Only female teachers were selected, as long-term, ongoing access to male schools was not feasible or possible for a female researcher in the UAE. As a mandate of the reform, all of these teachers had been required to implement cooperative learning for at least one year prior to conducting this research study. All 17 of these teachers were involved in the collection of a combination of formal and informal classroom observation data.

Although the implementation of cooperative learning in science classes was a requirement of the reform introduced by ADEC, the teachers, at the time of this study, were using cooperative learning strategies to different extents and with varying degrees of success. In selecting which teachers were using cooperative learning in an exemplary manner, I drew on classroom observations, advice from education advisors who worked regularly with teachers, and documentation (lesson plans and assessment rubrics). The criteria used for the selection of the teachers that

had an established understanding of and used cooperative learning in an exemplary manner was that the teacher:

- Incorporated the five essential elements of cooperative learning (outlined in Section 2.2) for most of their lessons;
- Organised the classroom for effective team work,
- Designed activities and tasks which encouraged students to collaborate, discuss concepts and question others all whilst fulfilling their assigned roles (manager, recorder/reporter or technician);
- Set specific homework assignments for students to complete individually before lessons so that students are prepared to work in their groups;
- Assessed students individually and in their assigned teams;
- Wrote lesson plans that were reflective of the criteria for the implementation of effective cooperative learning (taking into account the assessment and time allocations for group work);
- Encouraged students to reflect on the task or lesson and to discuss their successes and failures.

Of these 17 teachers, seven were selected as teachers with an established understanding of cooperative learning and 10 were not. The 10 teachers who were not implementing cooperative learning effectively were using strategies more closely aligned with traditional approaches and only sporadically implemented some cooperative learning elements and strategies (such as when they knew they would be observed by the education advisor or a member of school administration).

As the teachers are central to implementing any reform process, their views were likely to impact on students' responses to the surveys. It was with this in mind that data were collected from case study teachers who were considered to be implementing cooperative learning in an exemplary way. The seven teachers who

were identified as having an established understanding of cooperative learning became case study teachers (Creswell & Plano Clark, 2007). Careful selection of the teachers involved studying both the individuals and situations (classrooms) to encompass all areas of learning and teaching and to maximise the generalisability of the findings to the widest possible population (Shulman, 1997).

3.5 Collection of Quantitative Data

This section describes the instruments used to collect the quantitative data (described in Section 3.5.1) including the translation of both surveys into Arabic to make them suitable for use in the UAE, where students speak English as a second language (Section 3.5.2). Finally, this section describes the pilot testing of the instruments (Section 3.5.3).

3.5.1 Instruments Used to Collect Quantitative Data

Two surveys were used to collect the quantitative data for the present study: the What Is Happening In this Class (WIHIC), to assess students' perceptions of their learning environment (described in Section 3.5.1.1); and the Attitude towards Cooperative Learning (ACL) survey (modified from existing questionnaires), to assess students' motivation, attitudes and aspirations towards science (described in Section 3.5.1.2).

3.5.1.1 What Is Happening In this Class (WIHIC)

Given the robust nature of the WIHIC (described in Section 2.5.2.9) across a number of settings and in a variety of different languages, it was considered to be suitable for the present study. Although the WIHIC instrument is relatively new, it has been used to investigate classroom learning environments in different subject areas at different age levels, and in different countries. The WIHIC's reliability has been validated in science in a number of countries, including: Australia and Taiwan (Aldridge & Fraser, 2000; Aldridge et al., 1999), South Africa (Aldridge, Laugksch, Seopa, & Fraser, 2006); and Canada (Zandvliet & Fraser, 2005). The WIHIC has been translated into numerous languages, including: Mandarin (Aldridge & Fraser, 2000;

Aldridge et al., 1999); Korean (Kim, Fisher, & Fraser, 2000), Bahasa Malay (Khine & Fisher, 2001); and Indonesian (Margianti, Fraser, & Aldridge, 2001).

Previous versions of the WIHIC, translated for use in the UAE, had either been modified to suit college-level students (Afari et al., 2013) or did not report strong factor analysis for all scales (MacLeod & Fraser, 2010), therefore, it was necessary to modify and translate the WIHIC to ensure suitability for the present study. Five of the original seven scales that were considered to be relevant to a learning environment involving cooperative learning strategies were included, namely: student cohesiveness (the degree to which students know, help and are supportive of one another); teacher support (the degree to which the teacher assists, befriends, trusts and is interested in students); involvement (the degree to which students have attentive interest, participate in discussions, perform additional work and enjoy the class); cooperation (the degree to which students cooperate rather than compete with one another on learning tasks); and equity (the degree to which students are treated equally by the teacher). Table 3.1 provides examples of the scale name, description and a sample item for each of the scales of the WIHIC. Two WIHIC scales, investigation and task orientation, were not included because they were not considered to be relevant to the aims of this study.

The final version of the WIHIC survey included five scales, namely: student cohesiveness, teacher support, involvement, cooperation and equity. Table 3.1 provides examples of the scale name, description and a sample item for each of the scales of the WIHIC. Each scale of the WIHIC had eight items, providing a total of 40 items. The items were all positive and responded to using a five-point frequency-response scale of almost always, often, sometimes, seldom and almost never. Responses were entered into an Excel spreadsheet (scored 5, 4, 3, 2 or 1 for different responses) with all omitted or invalid responses being given a score of three (refer to Appendix A for a copy of the WIHIC used in this study).

Table 3.1 Scale Description and Sample Item for Each Scale of the Modified What Is Happening In this Class (WIHIC) Questionnaire

Scale	Description	Sample item
	<i>The extent to which...</i>	
Student Cohesiveness	Students befriend and support one another.	I work well with other class members.
Teacher Support	The teacher assists, befriends and shows interest in students.	The teacher helps me when I have trouble with the work.
Involvement	Students actively participate in class discussions, show interest and enjoy the class.	I explain my ideas to other students.
Cooperation	Students cooperate with each other during activities.	Students work with me to achieve class goals.
Equity	The teacher treats students equally, including opportunities to contribute to class discussions, attention and praise.	I get the same opportunity to contribute to class discussions as other students.

3.5.1.2 Attitudes towards Cooperative Learning (ACL)

To assess student attitudes towards science, a survey was developed that included eight scales. The development of the new instrument drew on two existing surveys, the Test Of Science-Related Attitudes (TOSRA) developed by Fraser (1981), and the Student Adaptive Learning Engagement Survey (SALES) developed by Velayutham, Aldridge, & Fraser (2011), each of which are discussed below.

The Test of Science-Related Attitudes (TOSRA) was developed by Fraser in 1981 to encompass the broad concept of science attitude. The original TOSRA consisted of five scales each with ten items or statements. Improvements and extensions were made to the original TOSRA, to support Klopfer's (1971) rationale of science

attitude. The final version had seven scales, namely: social implications; normality of scientists; attitude of science enquiry; adoption of scientific attitudes; enjoyment of science lessons; leisure interest in science; and career interest in science. Past research reports the successful use of the TOSRA in a range of studies where it has shown to be valid and reliable across numerous settings and languages. The TOSRA has been used in many countries including: Turkey (Telli, den Brok, & Cakiroglu, 2010); Indonesia and Australia (Fraser, Aldridge, & Adolphe, 2010); Taiwan (Lin & Crawley, 1987); and Brunei (Dhindsa & Chung, 2003).

The reliability and validity of the TOSRA across a range of contexts made its selection a sensible starting point for the new survey. Three scales were drawn on, as they were relevant to the aims of this study: social implications, adoption of scientific attitudes, and career interest in science. Only positively worded items from each of these scales were included. Some of the negatively worded items were changed to read positively, for example, 'Finding out about new things is unimportant' was changed to 'Finding out about new things is important'. Where scales included less than eight items, additional items were developed. Finally, the wording of some items was modified to ensure relevance to students in the UAE, for example: 'Working in a science laboratory would be an interesting way to earn a living' was changed to 'Working in a science laboratory, a hospital, or an engineering office or site would be an interesting way to earn a living'.

The Student Adaptive Learning Engagement Survey (SALES), developed by Velayutham, Aldridge, and Fraser (2011) was also drawn on for the development of the new attitude survey. The SALES consists of four scales, namely, self-efficacy, self-regulation, learning goal orientation and task value. The development of the SALES instrument involved identifying key determinants of students' motivation and self-regulation in science learning, based on theoretical and research underpinnings. Following the development of the SALES, a pilot study involving 52 students from two Grade 8 science classes indicated that the instrument had sound face validity. Further, analysis of data collected from 1,360 students in 78 classes across grades eight, nine and ten indicated that the SALES has strong construct validity (in terms of discriminant, concurrent and predictive validity) when used with lower secondary students (Velayutham, Aldridge, & Fraser, 2011). Although relatively new, the

SALES is made up of scales that were considered to be relevant to the research objectives of this study. All four scales were included in the ACL and no changes were made to the wording of any of the items. Prior to the translation of the surveys, however, individual items were scrutinised to ensure that they were suitable for use in the UAE context.

In addition to the seven scales described above, an additional scale, engagement, was developed to gather information about the degree to which students were engaged whilst working on class activities and tasks.

The final version of the ACL survey included eight scales: self-efficacy, self-regulation, learning goal orientation, task value, social implications, adoption of scientific attitudes, engagement and science career aspirations. Table 3.2 provides examples of the scale name, description and a sample item for each of the scales of the ACL.

Each scale of the ACL had eight items, providing a total of 64 items. The items were responded to using a five-point frequency-response scale of strongly agree, agree, uncertain, disagree and strongly disagree. To avoid confusion, all of the items in the ACL were positive and scored 5, 4, 3, 2 and 1, respectively. Omitted or invalid answers were given a score of three (Appendix B provides a copy of the ACL used in the present study).

3.5.2 Translation of Surveys

To make the surveys usable in the UAE context where students speak English as a second language, they were translated into Arabic. The Arabic translations of the surveys were generated using the process of translation, back-translation, verification and modification that is recommended by Ercikan (1998) and Warwick and Osherson (1973). This process involved, firstly, an independent expert in both languages translating the English version into Arabic. Secondly, an additional expert in both languages who was not familiar with the original English version back-translated each item back into English. The two English versions were then compared to ensure that they were consistent in meaning. Minor grammatical changes were made for the

items to read accurately. For example, ‘I knew how to proceed with a hard work’ was changed to ‘I can figure out how to do difficult work’ and ‘I have the desire to know the world that we live in’ was changed to ‘I am curious about the world in which we live’.

Table 3.2 Scale Description and Sample Item for Each Scale in the Attitudes Towards Cooperative Learning (ACL) Questionnaire

Scale	Description	Sample item
	<i>To assess...</i>	
Self-Efficacy	Students’ confidence and beliefs in their own ability to perform tasks.	I can complete difficult work if I try.
Self-Regulation	The degree to which the student controls and regulates the effort put towards performing tasks.	I don’t give up even when the work is difficult.
Learning Goal Orientation	The degree to which the student perceives themselves to be participating in science classes for the purpose of learning, understanding and mastering science concepts as well as improving skills.	One of my goals is to learn as much as I can.
Task Value	The degree to which the student perceives the science tasks in terms of interest, importance and utility.	What I learn satisfies my curiosity.
Social Implications	To assess whether science is worthy of time, resources and money.	Money used on scientific projects is worthwhile.
Engagement	The degree to which the student is involved in activities and tasks.	I am involved in experiments.
Adoption of Scientific Attitudes	The degree to which the student is curious and open to finding out about new things as well as listening to other people’s views.	In science experiments, I like to use new methods which I have not used before.
Science Career Aspirations	The degree to which the student is interested in or aspires to a science career.	When I leave school, I would like to work with people who make discoveries in science.

Although students spoke Arabic as their first language, at the time of writing this thesis they were taught predominantly in English. It was considered desirable, therefore, to provide students with a dual layout that would provide both the English

and Arabic version of each item. This layout had been used successfully in similar studies by Aldridge, Laugksch, and Fraser (2006) in South Africa, and Afari et al. (2013) in the UAE. The dual layout, included the Arabic version of each item followed by the English version directly underneath, is shown in Figure 3.1.

بيان Statement	لا أو افق بشدة SD	لا أو افق D	غير متأكد U	أو افق أو A	افق بشدة SA
الكفاءة الذاتية SELF-EFFICACY					
أستطيع معرفة كيفية القيام بعمل صعب I can figure out how to do difficult work	1	2	3	4	5
أستطيع إتقان المهارات التي يتم تدريسها I can master the skills that are taught	1	2	3	4	5

Figure 3.1 An example of the dual language layout of items on the surveys

3.5.3 Pilot Testing of Surveys

Both surveys were pilot tested in one all-female class ($n=28$), the selection of which is described in Section 3.4.1.4. Pilot testing involved the administration of surveys followed by interviews with selected participants. During the administration of the surveys, students were carefully observed to ensure that no technical difficulties were encountered. As they responded to the surveys, students were encouraged to ask questions if clarification was required on any of the items. Students took approximately 15 minutes to complete the ACL and approximately 10 minutes to complete the WIHIC. No technical difficulties were noted and none of the students commented about any other difficulties with both surveys when asked to provide feedback.

Following the administration of the surveys, a focus group interview was held with six students who volunteered to participate. The purpose of the interview was to ensure the readability and comprehensibility of individual items, to examine whether students could use the response format meaningfully and to ascertain that the items were interpreted in ways that were intended by the researcher. The focus group interview indicated that items were clear and readable and that the response format was meaningful. Given the positive response, no further modifications were made to the surveys following the pilot student interviews.

Once satisfied with the results of the pilot test, both the WIHIC and ACL were administered to 756 students. At the all-female schools, the surveys were administered to students at different intervals throughout the day, working around the school timetable to minimise disruption to lessons. The researcher was actively involved in the administration, attending the classes and distributing the surveys to students as well as providing instructions. The surveys were administered simultaneously in each of the all-male schools (usually in the morning). Given the difficulty for a female to gain access to the all-male schools, it was necessary for the surveys to be administered with the support of male teaching and support staff (social workers and laboratory specialists). To ensure consistency in the collection of the data, specific instructions were provided by the researcher. In all cases, students' participation was voluntary and the confidentiality of their responses was guaranteed. (Refer to Section 3.8 for further information about the consideration of ethical issues and how these were addressed at all stages of the research.)

3.6 Collection of Qualitative data

The qualitative data collected to address the fifth research question centred on the benefits and challenges encountered by teachers when implementing the cooperative learning approach. The qualitative data was collected sequentially following the collection of quantitative data. This section details the methods used for the collection of qualitative information employed in this study. More specifically, the teacher journal (Section 3.6.1), classroom observations (Section 3.6.2), researcher journal (Section 3.6.3), interviews with case study teachers (Section 3.6.4) and samples of activities, tasks and lesson plans (Section 3.6.5) are discussed below.

3.6.1 *Teacher Journal*

Seven case study teachers (the selection of whom is described in Section 3.4.2), were asked to keep a reflective journal for six weeks, documenting the benefits and challenges faced throughout the implementation of the cooperative learning approach. In addition to documenting the benefits and challenges, teachers were asked to document their thoughts and feelings about the implementation of

cooperative learning strategies. The teachers had freedom in terms of how often and how much they wanted to write, as long as the feedback was reflective in nature and encapsulated their overall experiences. Teachers were given six weeks to complete and return the journal.

3.6.2 Classroom Observations

One forty-five minute lesson taught by each of the seven case study teachers was formally observed. However, regular informal lesson observations were carried out by me in both the case study and non-case study teachers' classrooms as part of the regular, ongoing support provided to the teachers. This was carried out to provide the researcher with a first-hand indication of the ability of the activities to encourage student teamwork and interaction, student engagement levels and attitudes towards the tasks. The observations also served as another source of data to help to address the fifth research objective and to gather data on the successes and challenges teachers faced as they implemented cooperative learning strategies. One forty-five minute lesson taught by the ten female teachers who were not implementing cooperative learning effectively was also observed for the purpose of making comparisons. The researcher's presence in the educational setting was as a complete (non-participant) observer (physically detached from the activities and social interactions) to check perceptions, record field notes and analyse data (Anderson, 1998).

Observations were recorded as field notes to provide information related to student engagement, group work and the successes and challenges teachers encountered. During the lesson observation for each teacher, the researcher's activities were made known to the students, where I was a non-participant in an attempt to minimise my impact on the lesson. In my role as an education advisor, I routinely observed these classes, making the disruption to the teaching and learning minimal.

3.6.3 Researcher Journal

A running log in a journal format with detailed notes was kept as a running record by the researcher to document informal conversations with teachers and students and

record any other relevant field notes. This information was used when triangulating the data to help understand whether any anomalies in the data existed.

3.6.4 Interviews with Case Study Teachers

All of the case study teachers ($n=7$) were interviewed once following the classroom observations and the collection of the teacher journal. The aim of the interviews was to gather information about the teachers' views of the benefits and challenges of the cooperative learning approach and the progress of the implementation of cooperative learning (Research Question 5). In addition, the interviews ascertained whether teachers felt that students were more engaged or had more positive attitudes towards science lessons since the introduction of cooperative learning (Research Question 2).

For two of the teachers, key informant interviews were held. These key informant interviews were in-depth interviews and focus group interviews (the selection of informants is described in Section 3.4.2). Both of these teachers were interviewed individually and were able to provide a first-hand personal account of the experiences of implementing cooperative learning strategies. During the key informant interviews, a semi-structured format was used to ensure consistency whilst allowing the teachers to draw on their knowledge and experiences to provide a personal, first-hand account of the benefits and challenges they faced as they implemented cooperative learning.

A focus group interview involving a semi-structured format was conducted with the remaining five case study teachers. The purpose of using a focus group interview with these teachers was to ensure a comfortable environment in which I could elicit a broad range of opinions, feelings, attitudes or perceptions from a group of teachers, all of whom had shared common experiences with respect to the implementation of cooperative learning. Although the same questions were asked at the key informant interviews as at the focus group interview, the presence of many teachers encouraged informal discussion throughout the interview process. Therefore, teachers were able to discuss their first-hand accounts and experiences of implementing cooperative learning, and were also provided with an opportunity to further discuss their responses through discussion with their peers.

The interviews all involved Kvale's (1996, p. 8) seven stages of an interview investigation: (1) thematising, (2) designing, (3) interviewing, (4) transcribing, (5) analysing, (6) verifying, and (7) reporting. This choice of methods ensured that the interviews were thorough and consistent. During the interviews, notes related to body language, tone of voice and facial expressions were taken and the responses were audio recorded and transcribed verbatim. The responses were then analysed, verified and reported under four main themes in Chapter 5. Appendix C provides a sample of the teacher interview protocol.

Focus group and in-depth key informant interviews carried out with the case study teachers were transcribed verbatim. The interview questions posed to the participants were centred on the benefits and challenges faced whilst implementing cooperative learning. The transcribing of the interviews provided a complete record of the discussion and facilitated analysis of the data (Lewis, 2000).

3.6.5 Samples of Activities, Tasks and Lesson Plans

Sample activities and tasks, prepared by the teachers, were collected to provide information about the extent to which the activities or tasks were designed to engage the students and to promote discussion amongst the students. The samples also helped determine whether group roles were implemented and to what extent. The samples were collected during the lesson observations discussed above. The samples were an additional source of information that were analysed to help ascertain whether the activities and tasks were a successful or challenging aspect for the teachers.

Teacher's samples of lesson planning were collected to examine the extent to which engaging, meaningful activities were prepared and used in the teaching and learning of science. The plans were used to examine the activities given to students, providing particular detail on the activities and tasks that incorporated cooperative learning activities and tasks to encourage group work. Additionally, the lesson plans were analysed to examine the extent to which lessons were student-directed and to highlight student-centred tasks and activities. This information was used as an

indication to ascertain the successful implementation of cooperative learning by the selection of case study teachers.

3.7 Data Analysis

This section describes the methods of data analysis employed for each research question.

3.7.1 Research Question #1

To give confidence in the results of subsequent research questions, it was important to provide evidence to support the reliability and validity of the translated WIHIC and newly-developed ACL when used in the UAE context. The construct validity of both the WIHIC and ACL instruments was guided by the framework suggested by Trochim and Donnelly (2006), depicted in Figure 3.2, which suggests that both translation and criterion validity should be fulfilled. The analysis used to fulfil each of these criteria is discussed below.

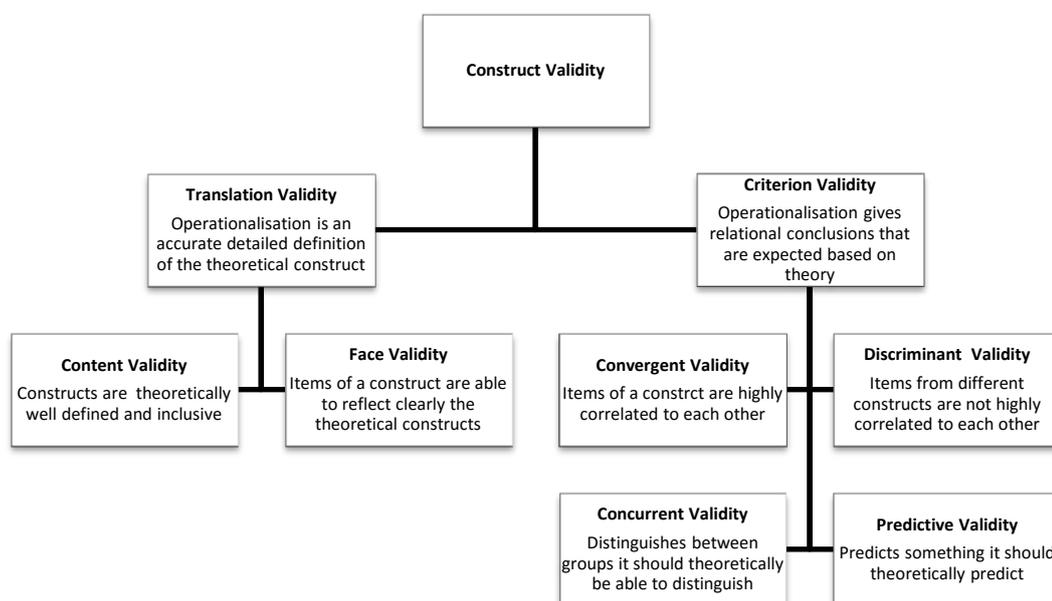


Figure 3.2 Framework for Construct Validity (Trochim & Donnelly, 2006)

Translation validity assures that the representation of the construct is accurate, based on theory and that it can be understood by the participants. Therefore, translation

validity comprises content validity (which focuses on whether the construct is theoretically sound and provides an all-encompassing representation of the construct) and face validity (which emphasises the need for a clear interpretation of the items, especially by the participants). As the WIHIC was a pre-existing survey and the ACL was drawn from pre-existing scales that were shown to be theoretically sound (see for example Fraser (1981) and Velayutham, Aldridge, and Fraser (2011), I did not check for translation validity. However, given that both versions had been translated into Arabic, it was important to examine the face validity of individual items. The face validity was checked during a pilot study in which students were asked to provide examples to back up their responses to the items. These responses were used to indicate whether students had interpreted the statements in ways that were intended by the researcher.

Criterion-related validity constitutes a more relational approach because it theoretically validates whether the construct provides the conclusions that are anticipated. Thus, the items of a distinct construct should be highly correlated to one another (convergent validity), whilst items from different constructs should not be highly correlated to one another (discriminant validity). Additionally, the construct must be able to predict something that it should theoretically predict (predictive validity) and differentiate between the groups that it is expected to differentiate between (concurrent validity). Hence, the instrument has high construct validity if it can establish content, face, convergent, discriminant, concurrent and predictive validity. Data collected from 784 students was used to examine the construct validity of both surveys, as recommended by Trochim and Donnelly (2006) in terms of convergent, discriminant and concurrent validity.

To examine the convergent validity, exploratory factor analysis with oblique rotation was performed separately for the WIHIC and ACL. It has been reported by Field (2009) that data involving humans are generally related. Thus, oblique rotation was utilised in the principal component analysis of the items to ensure the extraction of succinct sets of factors. Factor loadings were used to give an indication of how strongly each item was related to a particular factor. The criteria for retaining an item was that it must have a factor loading of at least 0.40 on its *a priori* scale and less than 0.40 on any other scales (Field, 2009). The cumulative variance was used to

check whether a sufficient number of factors had been retained, and eigenvalues showed the relative importance of each factor (Field, 2009). In addition to principal factor analysis, internal consistency reliability estimates, using the Cronbach alpha reliability coefficient, were used to assess the convergent validity of each instrument.

Discriminant validity examines the extent to which the scales in an instrument measure a different construct to scales that they should not be similar to. In the first instance, the principal factor analysis (described above) was used. The component correlation matrix, obtained from exploratory factor analysis with oblique rotation, was then used. To establish that each scale (examined separately for each instrument) measured a construct that was distinct from the other scales, Brown (2006) and Field (2009) explained that oblique rotation in exploratory factor analysis provides realistic representation of how factors are interrelated. According to Field (2009), based on theoretical grounds, there should be a moderately strong relationship between factors. Nevertheless, factor correlations above 0.80 imply overlap of concepts and point towards poor discriminant validity (Brown, 2006). Thus, the correlation matrix from the oblique rotation was analysed to ensure this condition was met.

Concurrent validity was assessed to make sure that each construct was able to distinguish between those groups which it was expected to distinguish between. Theoretical and research evidence has established that a unique feature of classroom learning environment questionnaires is their ability to differentiate between classes (Fraser, 1998a). Thus, each scale of the WIHIC and ACL should have the ability to differentiate the scores of students from different classes. Analysis of variance (ANOVA) was used to examine the ability of the scales in the two surveys to differentiate between classes (concurrent validity). The η^2 statistic, based on the ratio of the between-group effect to the total amount of variance in the data (Field, 2009), was calculated to provide information about the amount of variance attributed to class associations.

Finally, predictive validity was assessed as part of the second research question. Given that past research has shown that the learning environment is a strong predictor of student outcomes, predictive validity of the WIHIC and ACL involved examining the correlations between the scales of the two surveys.

3.7.2 *Research Question #2*

The second research question examined whether relationships exist between students' perceptions of a cooperative learning environment and their attitudes, motivation and science-related aspirations. To answer this research question, simple correlation and multiple regression analysis were used. As a first step, simple correlation analysis was used to examine the bivariate relationships between each attitude and learning environment scale. In the second step, multiple correlation analysis was undertaken using the set of five scales of the WIHIC questionnaire as independent variables and each attitude scale as the dependent variable. This analysis provided more parsimonious information about relationships between correlated independent variables and reduced the risk of a Type I error often linked with simple correlation analysis. To identify which of the individual learning environment scales were significant independent predictors of student attitudes, the standardised regression weights (β) were examined.

3.7.3 *Research Question #3*

To examine whether differences exist for students in classes in which cooperative learning strategies are implemented effectively and those who are not, in terms of their perceptions of the learning environment, attitudes towards science, motivation and engagement in science and science-related aspirations (Research Question 3), one-way multivariate analysis of variance (MANOVA) and effect sizes were used. The five WIHIC scales and eight attitude scales were used as the dependent variables and the instruction type (use of effective cooperative learning strategies or not) was used as the independent variable. In addition, the effect size for each scale was calculated, to determine whether these differences might be educationally significant (as recommended by Thompson, 2002). The effect size was calculated by dividing the difference between the two means by the pooled standard deviation, thus expressing the difference in the means of the two samples in standard deviation units.

3.7.4 Research Question #4

To compare whether exposure to cooperative learning was differentially effective for male and female students in terms of their perceptions of the classroom learning environment and attitudes towards science, two-way multivariate analysis of variance (MANOVA) was used. For the two-way MANOVA, the independent variables were students' exposure to cooperative learning and student sex (male and female), and the dependent variables were the five WIHIC and seven attitude scales. The sample of 784 students in 34 classes (12 classes of which were exposed to effective cooperative learning and 22 classes who were not) was used for the analysis. Because the two-way MANOVA yielded statistically significant results overall for each of the three effects (exposure to cooperative learning, sex, and exposure to cooperative learning versus sex), the univariate ANOVA was interpreted for each dependent variable for each of the three effects.

3.7.5 Research Question #5

To examine what benefits and challenges teachers encountered whilst implementing the cooperative learning teaching and learning approach, qualitative information was gathered. Anderson (1998) describes the analysis of qualitative data as a systematic process that organises the data into manageable units, combines and synthesises ideas, develops constructs, themes, patterns or theories and illuminates the important discoveries of the research. Most qualitative analysis, regardless of the particular qualitative orientation being adopted, follows a general, five-phased cycle of compiling, disassembling, reassembling (and arraying), interpreting, and concluding (Yin, 2011). Thus, this five-phased cycle was applied when analysing the qualitative data in this study, as described below. The aim of this analysis was to look for trends and patterns that appear within an interview or among interviews. Krueger (1988, p. 109) suggests that content analysis begins with a comparison of the words used in the answer. These words were used to group the statements into themes. A theme can be defined as a statement of meaning that runs through all or most of the pertinent data or a minor one that carries heavy emotional or factual impact (Ely, 1984).

In the initial phase, compiling and sorting the field notes and direct quotes from the interviews into distinct themes was adopted as a first step to analysis of the qualitative data. In order to get them into a systematic order, the themes were: the benefits and challenges faced by teachers whilst implementing cooperative learning; attitudes towards using cooperative learning; and beliefs about whether implementing cooperative learning was beneficial. The teachers' feelings and thoughts throughout the implementation process were also organised into positive and negative themes.

In the second phase, the collected data was disassembled into two main categories and rearranged into themes. The data was searched for disproving themes, and alternative interpretations of the data were tested to determine if there were any changes to the teachers' understanding of the information (Anderson, 1998). Pattern matching and comparisons, where patterns observed in the journal matched those noticed in lesson observations and/or questionnaire results, were noted. Regular communication with the teachers was paramount to gain an in-depth understanding of what the comments signified.

In the third and fourth phases, the reassembled data was interpreted to create a new narrative and ultimately make the sorted data the key analytic portion. Finally, in the fifth phase, conclusions were drawn from the interpretations gathered in the preceding phase to focus on the overall benefits and challenges teachers faced throughout the implementation of cooperative learning. This analysis was applied to all the qualitative data collected from the teacher journal and interview responses. There were four recurring themes that emerged: increased cooperation, reduced behaviour problems, ability to cater to different abilities, and assessment and resources.

3.8 Authenticity of Qualitative Data

The criteria used to ensure that the qualitative data were authentic and reliable was that suggested by Lincoln and Guba (1985). These criteria are intended to respond to four basic questions, concerned with truth value, applicability, consistency and neutrality. Connections can be made here, where: credibility resembles internal validity; transferability resembles external validity; dependability resembles

reliability; and confirmability resembles objectivity. Suitable techniques either to increase the probability that these criteria can be met or to test the extent to which they have been met are explained by Lincoln and Guba (1985).

Credibility encompasses prolonged engagement, persistent observation, triangulation, peer debriefing, negative case analysis and member checks. The cross-checking of data through triangulation was one way whereby the credibility of this study was addressed. Lesson observations, interviews and teacher journal entries were different data sources collected to triangulate the data and highlight the benefits and challenges teachers faced whilst implementing cooperative learning. In addition, lengthy contact (prolonged engagement) with the participants was necessary to assess possible sources of distortion in the data and as an avenue for clarification.

Transferability looks at providing thick descriptive data. Detailed accounts of the context, participants and methods of data collection and analysis were made available to the participants. Additionally, transcriptions of the case study teacher interviews verbatim from audio recordings were provided to enable other researchers to pass judgement on similarities to their own findings; this strategy addresses the transferability aspect of validity.

Dependability examines the process and confirmability is concerned with the data and reconstruction aspect of the study (Lincoln and Guba, 1985). Every attempt was made to ensure that the process was carefully planned and executed to cover all factors that played a role in influencing the teachers' implementation of cooperative learning. For example, sufficient time was given to teachers to complete the teacher journal, and teachers were encouraged throughout the interview to add additional information to answers if they needed to clarify them. Furthermore, all sources of qualitative data were carefully collected, stored and analysed meticulously to provide an opportunity for other researchers to reconstruct the study, the core of the confirmability criteria.

3.9 Ethical Issues

This section describes the ethical issues faced throughout this study and the ways in which they were addressed. These include: informed consent, voluntary involvement, confidentiality, and consideration, each of which is described below.

Informed consent from all participants was obtained before beginning the fieldwork. The verbal permission of school principals was sought before any research was carried out in their schools. Information was provided on the objectives of the study, the nature and type of data to be collected, the means of collection and how the data would be used. Principals and teachers were assured that the research and data collection would be carried out with minimal disruption to the teaching and learning programs in their schools. This was in order to minimise the effect of the study on the educational outcomes. The case study teachers signed a consent form after reading the participant information and asking questions (refer to Appendix D for a copy of the teacher information sheet and consent form).

It was made clear, both verbally and in writing, to all of the participants that their involvement was voluntary. Case study teachers were given the opportunity to withdraw from the study at any stage without it affecting their rights and responsibilities. By signing the consent form, teachers agreed to participate and gave their approval for the data collected from them to be reported in this study. Students consented to their involvement in the study when they agreed to voluntarily complete the surveys (refer to Appendix E for a copy of the student information sheet and consent form).

All participants were assured that the information provided in this study would be kept separate from any personal details, with only my supervisor and myself having access to this material. Participants were assured that the surveys and interview transcripts would not have their names or any other identifying information on it. This was done to protect participants and to prevent any bias by the readers should they know the schools or participants. Teachers had the right to review and suppress any data collected from their classrooms. The participating schools and subjects

were given the choice as to whether they would like to be acknowledged in the report.

Every effort was made to reduce the amount of class time taken up with all aspects of data collection. All of the surveys in the female schools were carried out in lessons in place of teachers who were absent, in order to minimise disruption. However, this was not guaranteed in the male schools, as the survey was administered to the male students in the randomly selected classes, but for the duration of only one lesson. Feedback and findings were shared with principals, teachers and students who requested them.

3.10 Chapter Summary

This study involved a multistrand design in which different methods were collected sequentially. Firstly, a large-scale administration of two questionnaires was central to the study and provided a general indication of how students in Abu Dhabi, UAE, perceived their learning environment, attitudes, motivation and engagement with science and science career aspirations. Secondly, data from observations of science lessons, in-depth interviews with teachers and journal entries kept by teachers were drawn on to examine students' responses and to clarify any inconsistencies in the data.

The data reported in this thesis was collected from students and teachers in science classes in eight public schools in Abu Dhabi, UAE. These schools were all middle school from grades six to nine (known in Abu Dhabi as Cycle 2 schools) catering for 12- to 15-year-old students. In keeping with the requirement of the Abu Dhabi Education Council, all eight of the schools were required to implement the cooperative learning approach in science lessons. Four of the schools were all-female and four were all-male. The 784 students (419 female students and 365 male students) in grades 6, 7, 8 and 9 who provided useable questionnaires were from 34 lower secondary science classes. There were 290 students in 12 classes that were exposed to effective cooperative learning and the remaining 494 students in 22 classes were not exposed to effective cooperative learning.

Seven female science teachers were chosen as case study participants and provided the qualitative sources of data. The selection of the case study teachers was primarily dependent, upon whether the teachers had an established understanding of implementing cooperative learning, as evidenced through regular observations of exemplary planning and delivery of lessons, as well as a willingness by the teacher to participate in the research. Teachers were carefully selected so that both individuals and situations were studied in order to maximise the generalisability of the findings to the widest possible population.

Two instruments were used in this study, these being the modified WIHIC (to assess student's perceptions of the classroom learning environment) and the newly-developed ACL (to assess student attitudes towards science) surveys. The WIHIC, a widely used learning environment questionnaire (which has, notably, been validated in a range of settings and countries) was modified to suit the aims of this study. The Arabic version of the WIHIC used in the present study consisted of 40 items in five scales - student cohesiveness, teacher support, involvement, cooperation and equity. The ACL was created by drawing on scales from two theoretically sound and previously validated instruments, the TOSRA and SALES. The final version of the ACL survey consisted of 64 items in eight scales: self-efficacy; self-regulation; learning goal orientation; task value; social implications; adoption of scientific attitudes; engagement; and science career aspirations. Both questionnaires were piloted on one class of grade seven students, followed by interviews with six students, to confirm whether the students were responding to the items in terms intended by the questionnaire as well as to provide examples and clarification of their selection of the items.

Qualitative information was collected from seven female teachers who were selected as case study participants. Teachers were asked to keep a reflective journal documenting the benefits and challenges they faced throughout the implementation of cooperative learning. Each case study teacher was formally observed and samples of activities and tasks as well as samples of lesson plans were collected and analysed. Each teacher was interviewed once either individually or as part of a focus group. I kept a research journal to document informal conversations with teachers and students.

To support the reliability and validity of the WIHIC and ACL, Trochim and Donnelly's (2006) framework for construct validity was used. According to this framework, a construct must fulfil both translation and criterion-related validity requirements. Factorial validity, scale reliability and ANOVA were used to assess the validity and reliability of the WIHIC and ACL questionnaires in this study. To examine the relationships between each attitude and learning environment scale, simple correlation and multiple correlation analyses were used (Research Question 2). To distinguish whether differences in perceptions of the learning environment and attitudes were present for students in classes in which cooperative learning strategies were implemented effectively, compared to students who were not exposed, one-way MANOVA was used (Research Question 3). To compare whether there are differences between male and female students in terms of perceptions of the learning environment and attitudes towards science (Research Question 4), two-way MANOVA and univariate ANOVA were employed.

To analyse the qualitative data, Yin's (2011) five-phased cycle was employed. This qualitative data was used to identify the benefits and challenges encountered by teachers as they implemented the teaching and learning strategies for cooperative learning (Research Question 5). The criteria used to ensure that the qualitative data were authentic and reliable were those suggested by Lincoln and Guba (1985). These criteria are intended to respond to four basic questions concerned with truth value, applicability, consistency and neutrality.

Every effort was made to ensure that ethical considerations were followed and issues addressed according to the guidelines. Informed consent was obtained from all participants and voluntary involvement was emphasised to give participants the freedom to withdraw from the study if they chose. Confidentiality of participant information was assured at all times, and consideration for the participants was of utmost importance to minimise disruption and respect for culture and religion. Ethics approval was obtained from Curtin University (refer to Appendix F) to carry out this study.

Chapters four and five present the results and analyses, providing answers to the five research questions posed in this study.

CHAPTER 4

ANALYSIS AND RESULTS: QUANTITATIVE DATA

4.1 Introduction

This chapter reports the results for the quantitative data analysis. As described in the previous chapter, two surveys were administered, the What Is Happening In this Class (WIHIC) questionnaire, to assess students' perceptions of the learning environment (refer to Section 3.5.1.1), and the newly developed Attitudes towards Cooperative Learning (ACL) survey, to assess student attitudes towards science (refer to Section 3.5.1.2). Both surveys were translated into Arabic using a process of back translation. The surveys were administered to a sample of 784 students in 34 classes. Of these classes, 12 were exposed to effective cooperative learning and 22 were not. This chapter reports the results under the following headings:

- Validation of the instruments (Section 4.2);
- Examining relationships between the learning environment and attitudes (Section 4.3);
- Exposure versus no exposure to effective cooperative learning strategies (Section 4.4);
- Differential effectiveness of cooperative learning for males and females (Section 4.5); and
- Chapter summary (Section 4.6).

4.2 Validation of the Instruments

To provide confidence in the results of subsequent research questions, the first question was asked:

Are modified and translated versions of the What Is Happening In this Class (WIHIC) and Attitudes towards Cooperative Learning (ACL) instruments,

which assess students' perceptions of the learning environment, attitudes, motivation, engagement and aspirations, valid and reliable when used in the UAE?

To address this research question, this section describes the face validity of each of the instruments (Section 4.2.1) and the convergent, concurrent and discriminant validity of both surveys, the What Is Happening In this Class (WIHIC) (Section 4.2.2) and Attitudes towards Cooperative Learning (ACL) (Section 4.2.3).

4.2.1 Face Validity of the Instruments

To ensure face validity, both surveys were pilot tested in one all-female class ($n=28$) in two phases: firstly, the administration of surveys (including the layout and design of the surveys, clear interpretation of the items by students, and time to complete the surveys (as recommended by De Vaus, 2002); and, secondly, interviews with the students (as recommended by Kvale, 1996).

Following the administration of the surveys, a focus group interview was held with six female students who volunteered to participate. The most salient check on face validity, according to Munby (1997), is to examine the opinions of a sub-sample about their comprehension of the items. The purpose of the interviews, therefore, was to ensure the readability and comprehensibility of individual items (to support the face validity of the survey), in order to ascertain that the items were interpreted in ways that were intended by the researcher (Cohen, Manion & Morrison, 2000). Also, the interviews provided an opportunity to determine whether students could use the response format meaningfully.

During the interviews, students were asked to give examples of their responses, during which there was much discussion amongst the students, who were eager to give their opinions. The interviews indicated that the participants interpreted the items in ways that were intended and it was established that items were suitable for use in the UAE context. For example, when asked to give examples for 'I am involved in hands-on activities' students responded by citing experiments and group work. Additionally, when asked to give examples for 'A career in science would be

exciting’, responses such as brain surgeon and petroleum engineer were responses. Some more samples of survey statements and example student responses can be found in Table 4.1. The student interviews confirmed the face validity for both the WIHIC and ACL instruments used in this study.

Table 4.1 Sample of Student Responses to Items on the WIHIC and ACL Surveys

WIHIC Survey Statement	Student Responses	ACL Survey Statement	Student Responses
<i>I learn from other students in this class.</i>	“Support each other if one makes a mistake, teacher fixes it and others learn.”	<i>I am involved in hands-on activities.</i>	“Experiments, group work”.
<i>I help other class members who are having trouble with their work.</i>	“Higher achievers support weaker students, explain to other students if they ask a question.”	<i>What I learn is helpful to me.</i>	“Science is linked to other subjects, e.g. Maths with graphs”.
<i>The teacher talks with me.</i>	“Encourages higher level students more and elects them for extracurricular activities, competitions, etc.”	<i>A career in science would be exciting.</i>	“Brain surgeon, petroleum engineer”.
<i>I work with other students in this class.</i>	“Work together very well, support each other, we prefer to work in groups because we can ask each other questions if we don’t understand.”	<i>Money spent on science is well worth spending.</i>	“Environmental sustainability, inventions, experiments to learn about new things”.
<i>When I work in groups in this class, there is teamwork.</i>	“Sometimes negative to work in groups as not all contribute, yet prefer group assessment to individual assessment.”	<i>Finding out about new things is important.</i>	“Ask people, internet searches, teach others new information”.

The bilingual (Arabic/English) layout of the surveys was also deemed appropriate for the intended sample, establishing the readability and comprehensibility of both instruments.

4.2.2 Construct Validity of the WIHIC

To investigate the construct validity of the translated (Arabic) version of the WIHIC when used in the UAE, the data collected from 784 students were used to examine the instrument's factor structure (described in Section 4.2.2.1), internal consistency reliability (described in Section 4.2.2.2), concurrent validity (described in Section 4.2.2.3) and discriminant validity (described in Section 4.2.2.4).

4.2.2.1 Factor Structure

The multivariate normality and sampling adequacy of the data were tested for the WIHIC. Bartlett's test of sphericity indicated that $\chi^2 = 19719.950$ and that this value was statistically significant ($p < 0.001$). The Kaiser-Meyer-Olkin measure of adequacy was high (0.97), confirming the appropriateness of the data for further analysis. Exploratory factor analysis using principal component factor analysis with oblique rotation was then carried out to extract salient factors. The two criteria for the retention of any item were that it must have a factor loading of at least 0.40 on its own scale and less than 0.40 on all other scales. The results, reported in Table 4.2, shows the factor loadings for each item was at least 0.40 on their *a priori* scale and less than 0.40 on the other four scales. Therefore, all 40 items were retained for further analysis.

The percentage of variance accounted for different scales, reported at the bottom of Table 4.2, ranged from 3.16% to 40.12%, with the total variances explained being 61.08%. Also, the bottom of Table 4.2 shows that the eigenvalues for different scales ranged from 1.27 to 16.05.

Table 4.2 Factor Loadings for the WIHIC

Item No	Factor Loading				
	Student Cohesiveness	Teacher Support	Involvement	Cooperation	Equity
1	0.75				
2	0.78				
3	0.81				
4	0.68				
5	0.70				
6	0.41				
7	0.59				
8	0.54				
9		0.81			
10		0.89			
11		0.79			
12		0.82			
13		0.65			
14		0.77			
15		0.72			
16		0.62			
17			0.64		
18			0.68		
19			0.45		
20			0.58		
21			0.74		
22			0.73		
23			0.58		
24			0.65		
25				0.40	
26				0.43	
27				0.53	
28				0.68	
29				0.70	
30				0.76	
31				0.81	
32				0.67	
33					0.67
34					0.76
35					0.77
36					0.74
37					0.76
38					0.80
39					0.75
40					0.78
% Variance	9.55	3.70	40.12	3.16	4.56
Eigenvalue	3.82	1.48	16.05	1.27	1.83

Factor loadings smaller than 0.40 have been omitted.

N= 784 Students in 34 classes.

4.2.2.2 Internal Consistency Reliability

The internal consistency reliability, using Cronbach's alpha coefficient, was calculated for each learning environment scale for two units of analysis (individual and class mean). The results, reported in Table 4.3, show that the alpha coefficients for the five scales ranged from 0.86 to 0.93, with the individual as the unit of analysis. The alpha reliability coefficients were higher when the class mean was used as the unit of analysis, ranging from 0.94 to 0.99, when the class mean was used as the unit of analysis. These reliability coefficients were all higher than Nunnally and Bernstein's (1994) minimum of 0.70 for satisfactory reliability.

Table 4.3 Internal Consistency Reliability (Cronbach Alpha Coefficient) for the WIHIC

Scale	Unit of Analysis	No of Items	Alpha Reliability
Student Cohesiveness	Individual	8	0.86
	Class Mean		0.94
Teacher Support	Individual	8	0.92
	Class Mean		0.98
Involvement	Individual	8	0.89
	Class Mean		0.96
Cooperation	Individual	8	0.90
	Class Mean		0.98
Equity	Individual	8	0.93
	Class Mean		0.99

The sample consisted of 784 students in 34 classes.

4.2.2.3 Concurrent Validity

To examine whether the WIHIC scales could distinguish between students in different classes, a one-way ANOVA was used. The ANOVA results, reported in Table 4.4, were statistically significant ($p < 0.01$) for all five WIHIC scales. The η^2 values ranged from 0.13 to 0.26. These results suggest that the Arabic version of the

WIHIC was able to distinguish between the perceptions of students in different classes.

Table 4.4 Ability to Differentiate Between Classes (ANOVA Results) for Two Units of Analysis for the WIHIC

Scale	ANOVA Eta ²
Student Cohesiveness	0.13**
Teacher Support	0.26**
Involvement	0.16**
Cooperation	0.18**
Equity	0.21**

** $p < 0.01$

The sample consisted of 784 students in 34 classes.

The eta² statistic (which is the ratio of 'between' to 'total' sums of squares) represents the proportion of variance explained by class membership.

4.2.2.4 Discriminant Validity

Finally, the correlation matrix, generated through the oblique rotation, was used to further examine the discriminant validity of the results. Brown (2006) and Field (2009) explain that oblique rotation in exploratory factor analysis provides a realistic representation of how factors are interrelated. According to Field (2009) theoretically there should be a moderately strong relationship between factors. However, factor correlations above 0.80 imply overlap of concepts and point towards poor discriminant validity (Brown, 2006). The component correlation matrix, obtained from the oblique rotation (reported in Table 4.5), showed that the highest correlation was 0.62 and thus all values met the requirements of adequate discriminant validity.

Table 4.5 Component Correlation Matrix for the WIHIC scales

Scale	Student Cohesiveness	Teacher Support	Involvement	Cooperation	Equity
Student Cohesiveness	–	0.43	0.44	0.52	0.51
Teacher Support		–	0.32	0.32	0.54
Involvement			–	0.62	0.35
Cooperation				–	0.38
Equity					–

The Arabic/English version of the WIHIC was judged to be valid and reliable when used in the UAE context. In all cases, students were able to explain their response choices for the survey items and were able to provide examples for their choice of response.

4.2.3 Reliability and Validity of the ACL Survey

The newly-developed ACL (the development of which is described in Section 3.5.1.2) was used to assess a range of attitudes related to science learning. The development of the Attitudes towards Cooperative Learning instrument drew on two existing surveys, the Test Of Science-Related Attitudes (TOSRA), developed by Fraser (1981), and the Student Adaptive Learning Engagement Survey (SALES), developed by Velayutham, Aldridge, & Fraser (2011). To investigate whether the translated (Arabic) version of the ACL was valid and reliable when used in the UAE, the data collected from 784 students was used to examine the factor structure (described in Section 4.2.3.1), internal consistency reliability (Cronbach alpha coefficient) (described in Section 4.2.3.2), concurrent validity (ANOVA results) (described in Section 4.2.3.3), and discriminant validity (described in Section 4.2.3.4).

4.2.3.1 Factor Structure

Firstly, the multivariate normality and sampling adequacy of the data were tested. Bartlett's test of sphericity indicates that $\chi^2 = 25347.258$ and that this value was statistically significant ($p < 0.001$). The Kaiser-Meyer-Olkin measure of adequacy was high (0.961), confirming the appropriateness of the data for further analysis. Exploratory factor analysis using principal component factor analysis with oblique rotation, and Kaiser normalisation was then carried out to examine the instrument's *a priori* factor structure.

As with the WIHIC, the two criteria for the retention of any item were that it must have a factor loading of at least 0.40 on its own scale and less than 0.40 on all other scales. During analysis, three items were found to be problematic and were removed from all further analysis, these being Item 11 for the self-regulation scale, Item 32 for the task value scale and Item 49 for the adoption of scientific attitudes scale.

The factor loadings for the remaining 61 items in 8 scales are reported in Table 4.6. All but one of the remaining 61 items had a factor loading of at least 0.40 on its own scale and less than 0.40 on the other seven scales. The exception is Item 10 for self-regulation, that did not load above 0.40 on its own or any other scale. This item was retained, however, as its inclusion was found to strengthen the structure of the scale and increase the instrument's internal consistency.

The bottom of Table 4.6 shows that the percentage of variance accounted for different scales ranged from 1.93% to 31.76%, with the total being 56.54%. Also, the bottom of Table 4.6 shows that the eigenvalues for different scales ranged from 1.18 to 19.37. These results support the factorial validity of the ACL scales when used with the sample of 784 students.

Table 4.6 Factor Loadings for the ACL Survey

Item No	Factor Loading							
	Self-Efficacy	Self-Regulation	Learning Goal Orientation	Task Value	Social Implications	Engagement	Adoption of Scientific Attitudes	Science Career Aspirations
1	0.65							
2	0.72							
3	0.69							
4	0.68							
5	0.66							
6	0.75							
7	0.70							
8	0.55							
9		0.60						
10		–						
12		0.62						
13		0.55						
14		0.55						
15		0.49						
16		0.44						
17			0.53					
18			0.44					
19			0.47					
20			0.56					
21			0.67					
22			0.75					
23			0.69					
24			0.70					
25				0.74				
26				0.74				
27				0.68				
28				0.75				
29				0.75				
30				0.62				
31				0.55				
33					0.69			
34					0.60			
35					0.49			
36					0.63			
37					0.57			
38					0.42			
39					0.55			
40					0.67			
41						0.57		
42						0.68		
43						0.80		
44						0.72		
45						0.81		
46						0.85		
47						0.70		
48						0.66		
50							0.49	
51							0.73	
52							0.66	
53							0.63	
54							0.63	
55							0.52	
56							0.40	
57								0.50
58								0.42
59								0.45
60								0.69
61								0.61
62								0.70
63								0.75
64								0.62
% Variance	2.79	1.93	3.87	31.76	2.40	5.83	4.77	3.19
Eigenvalue	1.70	1.18	2.36	19.37	1.46	3.56	2.91	1.9

Factor loadings smaller than 0.40 have been omitted.

N=784 Students in 34 classes.

4.2.3.2 Internal Consistency Reliability

Internal consistency reliability, using Cronbach's alpha coefficient, was calculated for each of the scales of the ACL. The results, reported in Table 4.7, indicate that with the individual as the unit of analysis, the alpha coefficients for the eight scales ranged from 0.80 to 0.90. When the class mean was used as the unit of analysis, the alpha coefficients ranged from 0.91 to 0.97 for each of the eight scales. Similar to the results obtained for the WIHIC (reported in Section 4.2.2.2) and based on Nunally and Bernstein's (1994) cut off of 0.70, these reliability coefficients were considered to be satisfactory.

Table 4.7 Internal Consistency Reliability (Cronbach Alpha Coefficient) of the ACL Survey

ACL Scale	Unit of Analysis	Number of Items	Alpha Reliability
Self-efficacy	Individual	8	0.88
	Class mean		0.96
Self-regulation	Individual	7	0.80
	Class mean		0.94
Learning goal orientation	Individual	8	0.86
	Class mean		0.97
Task value	Individual	7	0.89
	Class mean		0.97
Social implications	Individual	8	0.86
	Class mean		0.95
Engagement	Individual	8	0.90
	Class mean		0.95
Adoption of scientific attitudes	Individual	7	0.85
	Class mean		0.94
Science career aspirations	Individual	8	0.85
	Class mean		0.91

The sample consisted of 784 students in 34 classes.

4.2.3.3 Concurrent Validity

One-way ANOVAs were used to examine whether the scales of the ACL survey could distinguish between students in different classes. The ANOVA results, reported in Table 4.8, indicate the extent to which students in the same class have similar attitudes, while attitudes vary amongst classes. The results were statistically significant ($p < 0.01$) for all eight scales. The η^2 values ranged from 0.12 to 0.23 for the different ACL scales.

Table 4.8 Ability to Differentiate Between Faculties (ANOVA Results) for Two Units of Analysis for the ACL Survey

Scale	ANOVA η^2
Self-efficacy	0.20**
Self-regulation	0.13**
Learning goal orientation	0.14**
Task value	0.23**
Social implications	0.17**
Engagement	0.12**
Adoption of scientific attitudes	0.12**
Science career aspirations	0.13**

** $p < 0.01$

The sample consisted of 784 students in 34 classes.

The η^2 statistic (which is the ratio of 'between' to 'total' sums of squares) represents the proportion of variance explained by class membership.

4.2.3.4 Discriminant Validity

Finally, the correlation matrix, generated through the oblique rotation, was used to further examine the discriminant validity of the ACL. The results, reported in Table 4.9, show that the highest correlation was 0.47 and this value meets the requirements of acceptable discriminant validity, as recommended by Brown (2006).

Table 4.9 Component Correlation Matrix for the ACL Survey Scales

Scale	SE	SR	LGO	TV	SI	E	ASA	SCA
Self-efficacy (SE)	–	0.24	0.30	0.33	0.37	0.47	0.42	0.32
Self-regulation (SR)		–	0.35	0.39	0.19	0.37	0.32	0.23
Learning goal orientation (LGO)			–	0.35	0.28	0.28	0.28	0.11
Task value (TV)				–	0.18	0.34	0.26	0.24
Social implications (SI)					–	0.28	0.32	0.16
Engagement (E)						–	0.34	0.35
Adoption of scientific attitudes (ASA)							–	0.13
Science career aspirations (SCA)								–

4.3 Examining relationships between the learning environment and attitudes

The second research question asked was:

What relationships exist between students' perceptions of a cooperative learning environment and their:

- a. Attitudes towards science;*
- b. Motivation and engagement in science; and,*
- c. Science-related aspirations?*

To ascertain whether students' perceptions of the learning environment were related to their attitudes towards science and science-career aspirations, simple correlation and multiple regression analyses were employed. Simple correlation analysis was used to examine the bivariate relationships between each attitude and learning environment scale. Additionally, multiple regression analysis was undertaken using the set of five scales of the WIHIC questionnaire as independent variables and each attitude scale as the dependent variable. This analysis provided more parsimonious information about relationships between correlated independent variables and reduced the risk of a Type I error often linked with simple correlation analysis. To identify which of the individual learning environment scales were significant

independent predictors of student attitudes, the standardised regression weights (β) were examined.

The results of the simple correlations, reported in Table 4.10, indicate that all five WIHIC scales were statistically significantly ($p < 0.01$) and positively related to each of the eight attitude outcomes (self-efficacy, self-regulation, learning goal orientation, task value, social implications, engagement, adoption of scientific attitudes and science career aspirations). The multiple correlations, reported at the bottom of Table 4.10, were positive and statistically significant ($p < 0.01$) for all eight attitude outcomes. The multiple correlations (R) ranged between 0.40 and 0.49 for each outcome. To identify which of the learning environment scales contributed to the variance in students' attitudes, the standardised regression weights (β), reported in Table 4.10, were examined. The results are reported below for each of the learning environment scales.

The student cohesiveness scale assesses the extent to which students know, help and are supportive of one another. Examination of the standardised regression weights (β), reported in Table 4.10, indicated that student cohesiveness was a statistically significant ($p < 0.01$) independent predictor of four of the eight outcomes: learning goal orientation, task value, social implications and science career aspirations. All of the significant correlations were positive in direction, suggesting that, if students are given opportunities to get acquainted and to help and support one another, then they are more likely to have improved attitudes for these scales.

The teacher support scale assesses the extent to which the teacher assists, befriends, trusts and is interested in students. The findings, reported in Table 4.10, suggest that teacher support is a significant ($p < 0.01$) independent predictor of seven of the eight attitude outcomes, the exception being engagement. All of the significant correlations were positive, suggesting that teachers wishing to improve student attitudes should examine their interpersonal relationships with students and consider showing interest in students' problems, befriending and assisting them.

Table 4.10 Simple Correlation and Multiple Regression Analyses for Associations Between Teachers for Two Units of Analysis

Scale	Self-efficacy		Self-regulation		Learning goal orientation		Task value		Social implications		Engagement		Adoption of scientific attitudes		Science career aspirations	
	<i>r</i>	β	<i>r</i>	β	<i>r</i>	β	<i>r</i>	β	<i>r</i>	β	<i>r</i>	β	<i>r</i>	β	<i>r</i>	β
Student cohesiveness	0.20**	0.06	0.24**	0.02	0.28**	0.09*	0.18**	0.10*	0.17**	0.11**	0.32**	0.05	0.29**	0.04	0.12**	0.17**
Teacher support	0.43**	0.19**	0.37**	0.10*	0.34**	0.10*	0.47**	0.33**	0.42**	0.22**	0.27**	0.08	0.39**	0.20**	0.36**	0.16**
Involvement	0.39**	0.17**	0.40**	0.24**	0.32**	0.06	0.36**	0.11*	0.32**	0.02	0.42**	0.26**	0.37**	0.08	0.33**	0.17**
Cooperation	0.28**	0.18**	0.31**	0.02	0.30**	0.22**	0.28**	0.14**	0.29**	0.12*	0.39**	0.15**	0.36**	0.13*	0.25**	0.08
Equity	0.43**	0.22**	0.37**	0.15**	0.36**	0.20**	0.40**	0.12*	0.42**	0.25**	0.32**	0.11*	0.35**	0.07*	0.35**	0.15**
Multiple correlation (<i>R</i>)	0.48**		0.44**		0.40**		0.49**		0.46**		0.45**		0.44**		0.41**	

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

N = 784 students in 34 classes

The involvement scale assesses the extent to which students have attentive interest, participate in discussions, perform additional work and enjoy the class. The standardised regression weights (β) (reported in Table 4.10) indicate that involvement was a significant ($p < 0.01$) independent predictor of five of the eight attitude outcomes: self-efficacy, self-regulation, task value, engagement and science career aspirations. All of the significant correlations were positive, suggesting that if teachers plan for increased student involvement in lessons, then it is likely that the outcome will positively influence the five attitude scales listed above.

The cooperation scale assesses the extent to which students cooperate rather than compete with one another on learning tasks. The findings, reported in Table 4.10, suggest that cooperation is a significant ($p < 0.05$) independent predictor of six of the eight attitude outcomes: self-efficacy, learning goal orientation, task value, social implications, engagement and adoption of scientific attitudes. All of the significant correlations were positive, suggesting that increased student cooperation in lessons positively influences their attitudes.

The equity scale assesses the extent to which students are treated equally by the teacher. The findings, reported in Table 4.10, suggest that equity is a significant ($p < 0.01$) independent predictor of all eight attitude outcomes. All of the significant correlations were positive, suggesting that teachers wishing to improve student attitudes are encouraged to treat students in ways that are perceived as being fair and equitable.

Overall, these results indicate that students who are exposed to learning environments which are more cooperative (as indicated by these learning environment scales) are likely to have improved attitudes.

4.4 Exposure Versus No Exposure to Effective Cooperative Learning Strategies

To examine whether differences exist for students in classes in which cooperative learning strategies were implemented effectively and those who were not, in terms of

their perceptions of the learning environment, attitudes, motivation and engagement in science and science-related aspirations (Research Question 3), the study used one-way multivariate analysis of variance (MANOVA) and effect sizes. This sample included the 12 classes of students that were exposed to effective cooperative learning strategies ($n=290$) and the 22 classes that were not ($n=494$). As explained in Chapter 3, the five WIHIC scales and eight attitude scales were used as the dependent variables, and the instruction type (effective use of cooperative learning strategies or not) was the independent variable. In addition, the effect size for each scale was calculated to determine whether these differences might be educationally significant (as recommended by Thompson, 2002). The effect size was calculated by dividing the difference between the two means by the pooled standard deviation, thus expressing the difference in the means of the two samples in standard deviation units.

The results, reported in Table 4.11, indicate that, for the learning environment scales, teacher support ($p<0.01$, effect size=0.21 standard deviations) and cooperation ($p<0.05$, effect size=0.15 standard deviations) were statistically significantly different for students who were exposed to cooperative learning and those who were not. For the attitude scales, statistically significant ($p<0.05$) differences were found for three of the eight scales: self-efficacy (effect size=0.18 standard deviations); task value (effect size=0.29 standard deviations); and science career aspirations (effect size=0.21 standard deviations). In all cases, with the exception of teacher support, the students who were exposed to effective cooperative learning strategies scored higher for these constructs than their counterparts who were not. For the teacher support scale, students in classes in which cooperative learning strategies were not implemented effectively scored higher for this scale, which could be due to the nature of the individual work provided to students. The effect sizes for those scales with statistically significant differences ranged from 0.15 to 0.29 and, according to Cohen's (1992) criteria, were considered to be 'medium' in effect.

Table 4.11 Average Item Mean, Average Item Standard Deviation, Effect Size and MANOVA Results for Differences between Scores for Students Exposed or Not Exposed to Effective Cooperative Learning Strategies

Scale	Average Item Mean ^a		Average Item Standard Deviation		Difference	
	Exposed	Not Exposed	Exposed	Not Exposed	Effect Size	F
<i>Learning Environment</i>						
Student cohesiveness	4.27	4.22	0.78	0.76	0.06	0.95
Teacher support	3.59	3.82	1.04	1.14	0.21	8.51**
Involvement	3.79	3.73	0.91	0.95	0.06	0.64
Cooperation	4.06	3.92	0.91	0.91	0.15	4.37*
Equity	3.94	3.85	1.00	1.05	0.09	1.41
<i>Attitudes</i>						
Self-efficacy	3.89	3.75	0.77	0.78	0.18	5.83*
Learning goal Orientation	4.27	4.23	0.70	0.69	0.05	0.39
Task value	3.90	3.64	0.83	0.95	0.29	15.38**
Self-regulation	4.11	4.05	0.68	0.70	0.09	1.20
Social implications	3.85	3.79	0.80	0.77	0.08	1.18
Engagement	4.16	4.24	0.70	0.77	0.11	2.05
Adoption of scientific attitudes	4.15	4.14	0.76	0.74	0.01	1.06
Science career aspirations	3.65	3.46	0.88	0.91	0.21	8.17**

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

N= 494 students in 22 classes not exposed to cooperative learning and 290 students in 12 classes exposed to effective cooperative learning

^a Average item mean=scale mean divided by the number of items in that scale.

Effect size calculated using Cohen's $d = M_1 - M_2 / s_{pooled}$ where $s_{pooled} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$

4.5 Differential Effectiveness of Cooperative Learning for Males and Females

Section 4.4 reported the use of a one-way MANOVA to explore differences between the two instructional methods (exposure to effective use of cooperative learning and no exposure) in terms of learning environment scales and attitude scales. The only exceptions were the learning environment scales of teacher support and cooperation. It was reported that, for most scales, students perceived the learning environment and attitudes in similar ways, regardless of their exposure (or not) to cooperative learning. In contrast, this section reports the use of two-way MANOVA to identify the differential effectiveness of these methods of instruction according to student gender, in order to answer the fourth research question:

Is exposure to cooperative learning differentially effective for male and female students in terms of their perceptions of the classroom learning environment and attitudes towards science?

For the two-way MANOVA, the independent variables were the method of instruction (those exposed versus those not exposed to effective cooperative learning strategies) and student sex (male and female), and the dependent variables were the five learning environment and eight outcome scales. The sample of 784 students in 34 classes (12 classes of which were exposed to effective cooperative learning strategies and 22 which were not) was used for the analysis. Because the two-way MANOVA yielded statistically significant results overall for each of the three effects (method of instruction, sex, and method of instruction versus sex), the univariate ANOVA was interpreted for each dependent variable for each of the three effects. Table 4.12 summarises the results. The type of effect size used for reporting the strength of association between each effect (method of instruction, student sex, and the interaction) for each learning environment and attitude scale was the η^2 statistic, which is an estimate of the proportion of variance accounted for. The results for method of instruction (Section 4.5.1), student sex (Section 4.5.2) and the interaction between the method of instruction and student sex (Section 4.5.3) are discussed below.

4.5.1 Method of Instruction (Exposure to Cooperative Learning Strategies)

This aspect of the MANOVA/ANOVA focused on whether there were differences in exposure to cooperative learning, regardless of sex. The results, for the two-way MANOVA (with control for gender), reported in Table 4.12, indicated that teacher support was the only learning environment scale and task value and science career aspirations were the only outcome scales for which there were statistically significant ($p < 0.01$) differences. The η^2 (an estimate of the proportion of variance) was 0.10 or less for all scales.

4.5.2 Student Sex

This portion of the MANOVA/ANOVA focused on whether differences exist between males and females regardless of the exposure to cooperative learning. As reported in Table 4.12, statistically significant ($p < 0.05$) differences were found between males and females for student cohesiveness, teacher support, cooperation, self-efficacy, task value, engagement and science career aspirations. The proportion of variance for these significant differences (η^2) ranged from 0.01 to 0.04.

4.5.3 Interaction between Method of Instruction and Sex

Information about the differential effectiveness of cooperative learning strategies for females and males was obtained by examining the interactions between method of instruction (exposure to effective cooperative learning strategies) and sex identified through the two-way ANOVAs. The results, reported in Table 4.12, show that there were no statistically significant interactions between the method of instruction and sex for any of the learning environment scales. There were, however, statistically significant interactions for six of the eight outcome scales (the exceptions being learning goal orientation and social implications of science). Therefore the independent interpretations of exposure to cooperative learning differences and sex differences were valid only for the five learning environment scales and for the two outcome scales mentioned above.

Table 4.12 Two-Way MANOVA/ANOVA Results (F and Eta^2) for Exposure to Effective Cooperative Learning and Student Sex for each WIHIC and ACL Scale

Scale	Two-Way ANOVA Results					
	Exposure		Sex		Sex x Exposure	
	F	Eta^2	F	Eta^2	F	Eta^2
<i>Learning Environment</i>						
Student cohesiveness	0.00	0.00	30.21**	0.04	0.22	0.00
Teacher support	4.61*	0.01	6.96*	0.01	3.02	0.00
Involvement	0.68	0.00	1.33	0.00	1.71	0.00
Cooperation	1.42	0.00	26.92**	0.03	0.58	0.00
Equity	0.86	0.00	0.00	0.00	2.78	0.00
<i>Attitudes</i>						
Self-efficacy	3.53*	0.00	3.83*	0.01	9.42**	0.01
Learning goal orientation	0.35	0.00	1.47	0.00	2.76	0.00
Task value	7.93**	0.01	8.13**	0.01	13.88**	0.02
Self-regulation	0.14	0.00	1.89	0.00	11.72**	0.02
Social implications	0.26	0.00	2.78	0.00	3.01	0.00
Engagement	0.71	0.00	19.22**	0.02	3.67*	0.01
Adoption of scientific attitudes	0.04	0.00	2.52	0.00	7.37**	0.01
Science career aspirations	4.14*	0.00	4.35*	0.04	7.17**	0.01

$N=$ 494 students in 22 classes not exposed to cooperative learning and 290 students in 12 classes exposed to effective cooperative learning

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

Table 4.12 shows that the amount of variance accounted for by the statistically significant ($p<0.05$) interactions between exposure to effective cooperative learning strategies and sex (in terms of eta^2 statistic) was 0.01 for self-efficacy, engagement, adoption of scientific attitudes and science career aspirations and 0.02 for task value and self-regulation.

Table 4.13 Average Item Mean, Average Item Standard Deviation and Differences in Scores (Effect Size) for Male and Female Students Exposed and not Exposed to Cooperative Learning for WIHIC and ACL Scales

Scale	Sex	Average Item Mean		Average Item Standard Deviation	
		Not Exposed	Exposed	Not Exposed	Exposed
<i>Learning Environment</i>					
Student cohesiveness	Female	4.38	4.41	0.72	0.69
	Male	4.09	4.06	0.85	0.78
Teacher support	Female	3.47	3.79	1.09	1.08
	Male	3.82	3.85	1.21	1.01
Involvement	Female	3.73	3.89	0.90	0.91
	Male	3.74	3.71	1.06	0.91
Cooperation	Female	4.17	4.14	0.77	0.84
	Male	3.86	3.73	1.10	0.93
Equity	Female	3.81	4.02	1.05	1.04
	Male	3.95	3.89	1.06	0.96
<i>Attitudes</i>					
Self-efficacy	Female	3.65	3.93	0.76	0.77
	Male	3.95	3.86	0.79	0.77
Learning goal orientation	Female	4.26	4.31	0.66	0.66
	Male	4.28	4.16	0.78	0.71
Task value	Female	3.49	3.93	0.96	0.80
	Male	3.93	3.87	0.85	0.86
Social implications	Female	3.86	3.72	0.72	0.85
	Male	3.92	3.85	0.92	0.81
Engagement	Female	4.28	4.35	0.60	0.65
	Male	4.14	3.99	0.85	0.83
Adoption of scientific attitudes	Female	4.12	4.29	0.74	0.66
	Male	4.19	4.04	0.80	0.79
Self-regulation	Female	3.96	4.17	0.68	0.72
	Male	4.22	4.06	0.65	0.67
Science career aspirations	Female	3.34	3.68	0.84	0.87
	Male	3.67	3.63	1.01	0.89

N=494 students in 22 classes not exposed to cooperative learning and 290 students in 12 classes exposed to effective cooperative learning
365 males and 419 females

To better understand the interactions between the method of instruction and sex, Table 4.13 shows the average item mean and average item standard deviation for male and female students who were exposed to effective cooperative learning strategies and those who were not. The average item means can be used in the interpretation of the statistically significant interactions between exposure and sex. The interpretation of the significant interactions ($p < 0.05$) for self-regulation (Figure 4.1), engagement (Figure 4.2) and adoption of scientific attitudes (Figure 4.3) is that, in classes exposed to effective cooperative learning strategies, females scored higher than males whereas in classes not exposed to effective cooperative learning, males scored higher than females. This could indicate that, in classes exposed to effective cooperative learning strategies, females are more likely to show more self-regulation, engagement and adopt scientific attitudes than males. On the other hand, in classes not exposed to cooperative learning practices it is the males who are more likely to have self-regulation, engagement and adopt scientific attitudes.

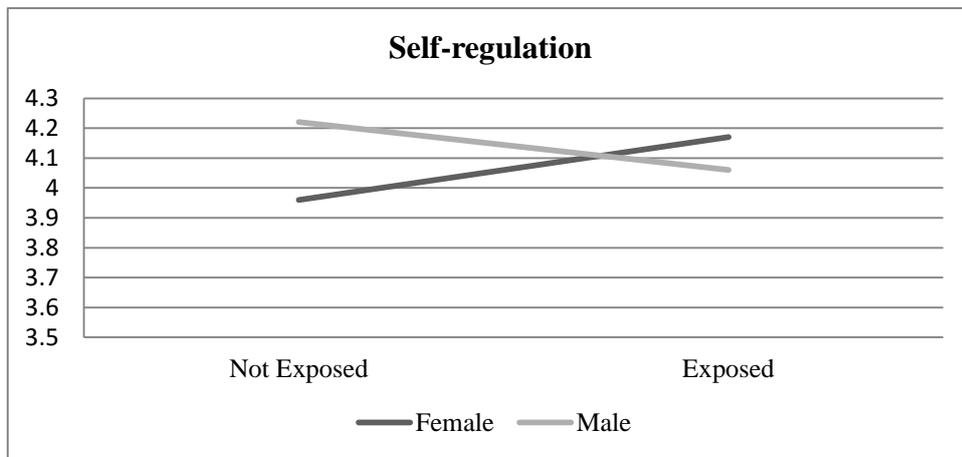


Figure 4.1 Exposure to Effective Cooperative Learning by Gender Interaction for Self-regulation

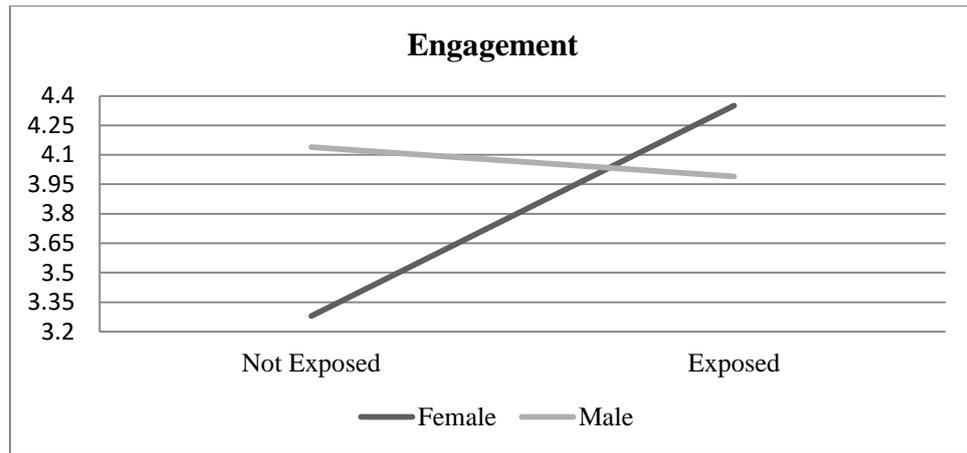


Figure 4.2 Exposure to Effective Cooperative Learning by Gender Interaction for Engagement

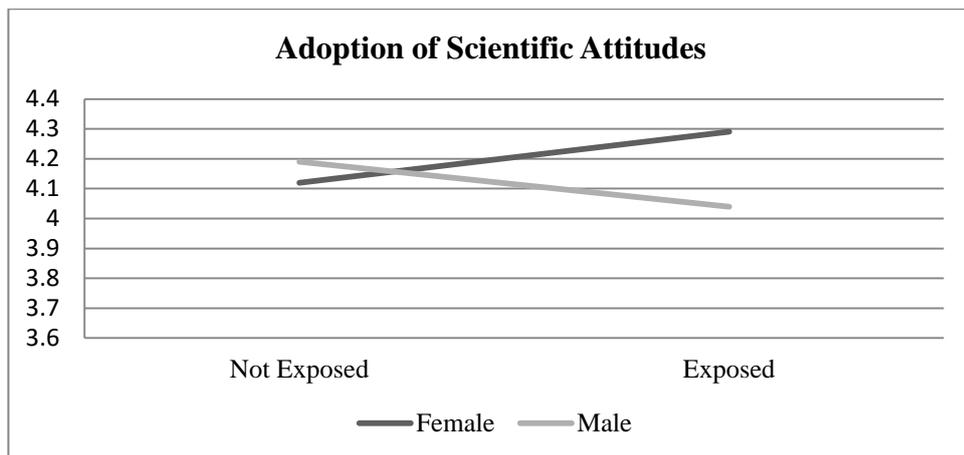


Figure 4.3 Exposure to Effective Cooperative Learning by Gender Interaction for Adoption of Scientific Attitudes

The interpretation of the significant ($p < 0.05$) interactions for self-efficacy (Figure 4.4), science career aspirations (Figure 4.5) and task value (Figure 4.6), is that, in classes not exposed to cooperative learning strategies, males held more positive attitudes than females. However, in classes exposed to cooperative learning strategies, males and females had similar attitudes.



Figure 4.4 Exposure to Effective Cooperative Learning by Gender Interaction for Self-efficacy

These findings suggest that, although cooperative learning is similarly effective for females and males, in terms of self-efficacy, science career aspirations and task value, males are more positive than females in classes not exposed to cooperative learning. These findings suggest that in terms of these scales, females fare better in classes with cooperative learning.

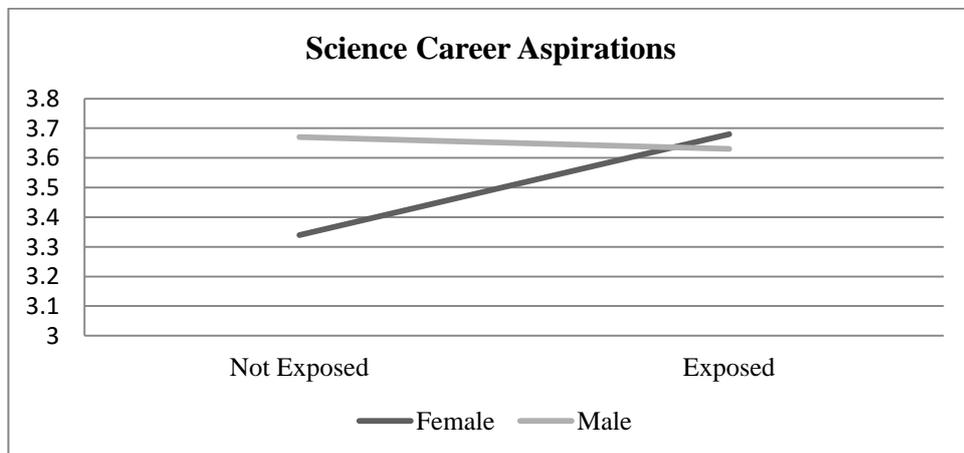


Figure 4.5 Exposure to Effective Cooperative Learning by Gender Interaction for Science Career Aspirations

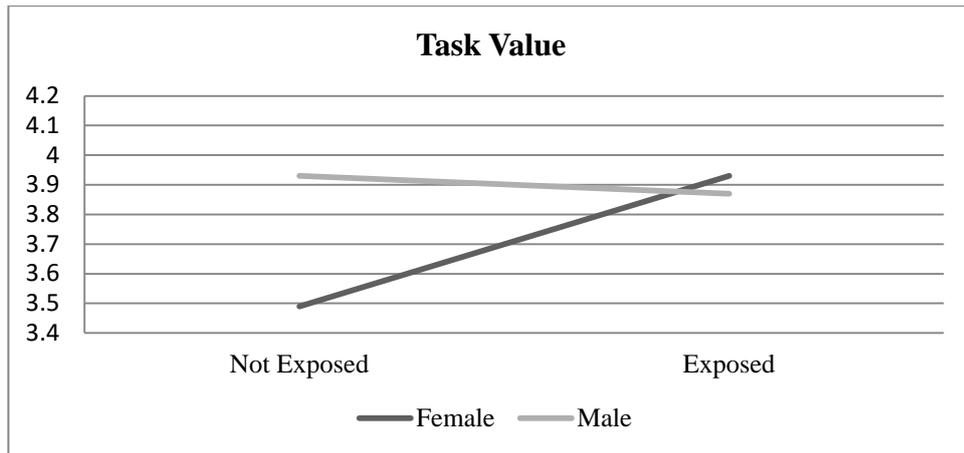


Figure 4.6 Exposure to Effective Cooperative Learning by Gender Interaction for Task Value

4.6 Chapter Summary

This study involved 784 students from 34 lower secondary science classes in eight public schools in Abu Dhabi, of which 12 classes were exposed to effective cooperative learning and 22 classes were not. Of these, 419 students were female and 365 students were males. There were five questions addressed in this research, focusing on both student and teacher perspectives on the effects of implementing effective cooperative learning strategies in science classrooms in Abu Dhabi, the United Arab Emirates.

It was important to prove that the translated What Is Happening In this Class (WIHIC) and Attitude towards Cooperative Learning (ACL) surveys were valid and reliable when used in the UAE. Validation of the instruments (Research Question 1) was guided by Trochim and Donnelly's (2006) construct validity framework. The concurrent, convergent and discriminant validity of the scales of the WIHIC and ACL surveys were examined. To investigate whether the translated (Arabic) versions of the two surveys are valid and reliable when used in the UAE, the data collected from 784 students were used to examine the factor structure, scale reliability (alpha reliability coefficient) and ability to differentiate between classes (ANOVA).

To examine the relationships between students' perceptions of the learning environment and their attitudes, motivation, engagement and career aspirations

towards science (Research Question 2), simple correlation and multiple regression analysis was used. The results of the simple correlations indicated that all five learning environment scales were statistically significantly ($p < 0.01$) and positively related to each of the eight outcomes. Further, the multiple correlations were positive and statistically significant ($p < 0.01$) for all eight attitude outcomes.

To examine whether differences exist for students in classes in which cooperative learning strategies were implemented effectively and those who were not (Research Question 3), a one-way multivariate analysis of variance (MANOVA) was used. The sample included 290 students in 12 classes who were exposed to effective cooperative learning and 494 students in 22 classes who were not exposed to effective cooperative learning strategies. The findings indicated that for the learning environment scales, teacher support ($p < 0.01$) and cooperation ($p < 0.05$) were statistically significantly different for students who were exposed to cooperative learning and for those who were not. For the attitude scales, statistically significant ($p < 0.05$) differences were found for three of the eight scales, these being self-efficacy (effect size=0.18 standard deviations), task value (effect size=0.29 standard deviations) and science career aspirations (effect size=0.21 standard deviations). With the exception of teacher support, the students who were exposed to effective cooperative learning strategies scored higher for these constructs than their counterparts who were not.

To determine whether exposure to cooperative learning was differentially effective for male and female students (Research Question 4), a two-way multivariate analysis of variance (MANOVA) was used. The results indicated that there were no statistically significant interactions between the method of instruction and sex for any of the learning environment scales but that there was a statistically significant interaction for six of the eight attitude scales (the exceptions being learning goal orientation and social implications of science).

In addition to quantitative methods, reported in this chapter, qualitative information from the teachers' perspective was also included. As the teacher is central to implementing any reform processes, including cooperative learning, their views were likely to impact on students' responses to the surveys. It was with this in mind that

data were collected from case study teachers who were considered to be implementing cooperative learning in an exemplary way.

The next chapter presents the qualitative results and data analysis from the seven case study teachers.

CHAPTER 5

ANALYSIS AND RESULTS: QUALITATIVE DATA

5.1 Introduction

As reported in the previous chapter, there were some statistically significant differences which favoured the classes in which students were exposed to effective cooperative learning (with the exception of teacher support). However, there was a degree of disappointment with the results, as it was anticipated that these differences would be greater. The analysis of the qualitative data helped to explain the differences found in the quantitative data and to provide an understanding of why cooperative learning was not implemented to a greater extent in science classes. The second strand of the present study was the gathering of qualitative information using classroom observations, journal entries and in-depth interviews with teachers.

As explained in Chapter 1, cooperative learning strategies in science classrooms, as part of a large-scale education reform effort, were introduced to encourage teamwork and engender a love for science, with the long-term view of inspiring students to select careers in the sciences. Initially, science curriculum specialists and education advisors provided training to science teachers. At the training session, teachers were supplied with information on cooperative learning with a focus on the aims and objectives of cooperative learning, protocols for group establishment, the format by which cooperative learning was to be implemented in science classrooms (in terms of grouping students) and how the students were to be assessed (all to be team assessments with the exception of individual tests). Appendix G provides the cooperative learning booklet provided to all teachers. Whilst the previous chapter focused on the students' perceptions of the learning environment and attitudes in science classes, this chapter examines the teachers' views of the implementation of cooperative learning in the UAE setting. Specifically, this chapter addresses the fifth research question:

What are the benefits and challenges of implementing effective cooperative learning as part of the teaching and learning process?

Qualitative data, including classroom observations, interview data, sample activities and tasks, lesson plans and journal entries, were collected from the seven female case study teachers, and observation data was collected from the classes of eight teachers not exposed to effective cooperative learning. As described in Chapter 3, only female participants were included in this component of the research, because long-term, ongoing access to male participants in the UAE was not a viable option for a female researcher. Analysis of the findings was used to provide a more holistic picture of the implementation of cooperative learning and how this impacted on student perceptions of the learning environment, and their engagement, motivation and cooperation in science lessons. Yin's (2011) five-phase cycle, detailed in Section 3.7.5, was employed to analyse the qualitative data. This chapter is organised under five sections - the four recurring themes which emerged during analysis of the qualitative data, and the chapter summary.

- Increased cooperation and reduced behaviour problems (Section 5.2);
- Ability to cater for students of differing abilities (Section 5.3);
- Assessment (Section 5.4);
- Resources (Section 5.5); and
- Chapter summary (Section 5.6).

5.2 Increased Cooperation and Reduced Behaviour Problems

In all of the lessons given by the seven case study teachers (those who were incorporating cooperative learning effectively), small group work was used, whereby three or four students were grouped together and worked as a team. For most of the lessons (especially during assessments), the groups were made up of students with similar abilities; occasionally, however, teachers grouped students so that each group was made up of students of a range of abilities. The students appeared to work well together and were generally engaged and on-task, as evidenced from the

conversations occurring within the group as well as observations of student body language and actions. A group of students were approached and asked whether they enjoyed working together. The general answer was “yes”, with some students explaining that when they worked in groups, it makes working on the set tasks easier because they could help each other (by dividing the workload) and were able to share ideas and have concepts explained by their peers if they did not understand.

The ten teachers who were not implementing cooperative learning well would sporadically implement cooperative learning strategies into science lessons, especially when the teachers knew they would be formally observed by a member of the senior leadership team or the advisor. The classes of these ten teachers, whose teaching styles were traditional, differed from the case study teacher’s classes, because the case study teacher’s classes implemented cooperative learning on an ongoing basis. Analyses of the qualitative data indicated that, when compared to classes that were not using cooperative learning strategies, the implementation of cooperative learning in science lessons resulted in enhanced cooperation and communication between students.

The case study teachers all agreed that, when involved in group work, students were less likely to be disruptive. To this end, one of the teachers recorded in her teacher journal that: “One benefit of group work was improved student behaviour, as the group roles kept students busy” [Journal Entry, Teacher A]. Compared to when students worked alone, the case study teachers felt that group work had a positive influence in terms of reduced behaviour problems, increased cooperation and communication, and improved opportunities for teachers to support the weaker students.

Analysis of the qualitative data received from the case study teachers indicated that, when students worked in their assigned groups as opposed to working individually, there were fewer off-task behaviours and behaviour problems. My observations confirmed the teachers’ reports. Although the noise levels were generally higher during the lessons that incorporated group work (when compared to those that did not), this was often a result of students vying to be heard as they discussed concepts

and shared ideas. Observations of individual groups indicated that, on the whole, the noise was work-related.

I noted during my observations in the seven case study classes, that, when involved in group work, the students were generally engaged in the task and worked well together. For example, during one observation of a grade 8 science class held in the laboratory, I noted that there was sharing of ideas (when students were planning the method for the investigation task) and regular support (discussion and clarification of concepts and results) amongst students within the groups. In general, my observations of lessons with cooperative learning groups suggested that this engagement could be due, in part, to the roles and subsequent responsibilities involved in cooperative learning. Regardless of what role each student played, I observed one constant throughout the lessons: the students' encouragement and support of one another. For example, during one lesson that I observed, one of the students repeated her explanation of an answer to her peers. She did this a few times during the discussion until all group members understood her explanation. This, in turn, seemed to encourage the students to engage in a whole class discussion at the end of the lesson. Students also helped each other physically, such as assisting the technician in tidying up the equipment at the end of experiments.

These seven case study teachers all reported some challenges during lessons, such as the need to encourage weaker students to contribute and a small number of students who were frequently off-task (physically away from the group, often chatting to classmates in other groups and not participating in their assigned group role). Teachers usually dealt with the students not following instructions by instigating the classroom rules and issuing the relevant consequences.

The case study teachers also agreed that, because students were working according to their assigned roles (discussed in Chapter 3), they were on-task, thereby providing less opportunity for misbehaviour. To this end, one teacher said:

Of course, working in groups was more enjoyable. They [the students] encourage each other and maybe if one student doesn't understand something like a section of the experiment, for example, when she

works with other students in her group the idea is clarified by her team mates. [Teacher A]

I observed that, in classes that effectively employed cooperative learning strategies, there appeared to be more cooperation between students (when compared to students in classes not implementing cooperative learning). For example, in one of these classes, I observed a group working together cooperatively as follows: the recorder/reporter was responsible for drawing up the plan (detailing the topic content and determining what each member would contribute to the overall product); the manager led the discussions and drew up a timeline for the students so that they were able to complete their work by the due date; and the technician was observed making a list of the resources/equipment they would need and was searching online when the group was looking up information. This team effort gave students the opportunity to collaborate and assist one another should any issues arise. On this point, one of the teachers commented, “There were lots of benefits when students work together: they help each other, support each other and it is sometimes a motivation for them” [Teacher D]. Another teacher wrote in her journal that “Students participate, support and are cooperative when working in their groups” [Journal Excerpt, Teacher F].

I had the sense that, in classes where effective cooperative learning was used, all of the students did their share during group work. I noted regularly in my classroom observations that students assisted one another. For example, the students explained difficult concepts to their peers when answering written questions (such as the questions posed in the discussion section of an experiment). Interestingly, I also observed students not wanting to be the cause of adversity for either themselves or their group members, possibly because the activity would be assessed and all of the students in the group would receive the same grade. For example, I observed, on a number of occasions, that students who held the role of technician were at pains to ensure they were following the method carefully and correctly. Overall, I observed the students’ willingness to assist one another, providing explanations to their peers when concepts were difficult and working together to complete the set task. The data collected during my interviews with these case study teachers generally reflected these observations and, one of the teachers remarked that:

All three students [in a group] contribute, not just one or two. There is encouragement and more of a liking towards learning because there is more involvement by the students. There is an increase in feeling a responsibility by the students and the number of hands-on activities per lesson has increased. Additionally there is distribution of roles within the group for each student, such as one student as the recorder, one as the technician and one as the resource manager, meaning all is organised well so that each student knows what their task is. Also student skills have improved; for example, they discuss together in the groups, they put up a plan, they distribute the workload and roles and adhere to the timeframe. [Teacher A]

5.3 Ability to Cater for Students of Differing Abilities

Analysis of the qualitative data (classroom observations, interviews and teacher journals) indicated that the effective use of cooperative learning strategies enabled the teachers to cater for students' differing abilities. It appears that teachers using cooperative learning effectively were better able to provide support for weaker and special needs students and challenge the gifted and talented students than those who were not. Further, when students were grouped according to abilities, the groupings themselves were used by teachers to cater for the students' differing abilities in science lessons.

The teachers who were effectively implementing cooperative learning strategies appeared to be in a better position to cater for students of differing abilities by providing differentiated tasks, than were those teachers who were not implementing these strategies. One example of a case study teacher catering to the differing abilities of students in a class was when she distributed differentiated worksheets to the groups. After providing a short explanation of what was required and addressing minor questions, the teacher was observed to physically move to a group of lower-ability students. The teacher sat with the group for a short time, providing simple, detailed explanations and examples to further guide this group of students in completing their work. She did the same with another lower-ability group, providing support and answering questions that the students posed. The teacher then proceeded to walk around the classroom, returning regularly to the front of the classroom to

monitor the progress of the students as well as provide support if and when the need arose.

Teachers who were effectively using cooperative learning strategies appeared to be in a better position (than teachers who were not) to challenge the higher-ability students by including open-ended enquiry tasks, whereby teachers posed a question with no further guidance, encouraging the higher-ability students to support the lower-ability students by serving as a mentor and posing higher order thinking questions and setting problem-solving tasks. In comparison to lessons that did not incorporate these differentiation strategies, I observed the higher ability students in these lessons to be generally less bored, more engaged and on task with their set activities and tasks.

Journal entries and interviews with the case study teachers supported the notion that, when they implemented cooperative learning strategies, they were able to cater to the needs of different students. On this point, an excerpt from one teacher's journals stated that there was "more focus on the weaker and special needs students, to provide support and offer activities matching with their academic levels" noting that, as a result, "weaker students have improved in science" [Journal Entry, Teacher M]. Another teacher said: "It gives you a small job because you focus on the weak girls instead of focusing on each group, so you notice you have one or two groups and it will not be hard" [Teacher N]. Another teacher said:

It's good if they [the students] are in the same levels or abilities. I am able to give groups additional tasks [to suit their abilities]. I can give them, for example, more difficult work and it is easier for following up with the weaker students where I can be closer [physically] to them [at their tables], give them easier tasks - something simple to match their levels. [Teacher A]

Another teacher said:

The clever girls are able to cooperate with others to support them and to work with them. For the weak students, [using groups allowed me]

to focus on them as they were close to me. These can also be the naughty girls because they don't always catch what we are discussing and they can disrupt the class. Using groups gives me the chance to limit the misbehaviours that I had faced in earlier years and, at the same time, it is good for their academic achievement. [Teacher F]

Analysis of work samples, related to investigation tasks further supported the notion that the use of groups helped the case study teachers to cater for students of differing abilities. For example, the work samples of one of the teachers showed how she had differentiated between three different ability groupings (one for each of low, medium and high abilities). The weaker students were provided with cues, such as 'fill in the blanks to complete the aim'. There were also differences between the level of support given to her medium-ability students, who were provided with a results table that had been drawn for them but had no titles; in the case of the lower level, students were given the table drawn with titles and were only required to record the results data. The higher level students, on the other hand, were given an investigation sheet that had the titles for each section of the investigation and little other additional support. The higher ability students and most medium ability students were observed to be self-dependent and to support fellow classmates if and when the need arose.

The qualitative findings suggest that the implementation of cooperative teaching and learning strategies in science lessons enabled teachers to cater for the differing abilities of students. Teachers reported that they were able to provide extra support for weaker and special needs students, and to challenge the gifted and talented students as well as having them support the weaker students in their science tasks if and when the need arose.

5.4 Assessment

In terms of assessment, analysis of the qualitative data indicated that there were a number of benefits when teachers implemented cooperative learning strategies effectively. These benefits included: reduced workload (for both teachers and students); increased responsibility (students assigned group roles with responsibilities); and higher levels of student engagement.

Analysis of the qualitative data indicated that one of the advantages of assessing students in their cooperative learning groups (over assessing them individually) was that only one product for each group of students was required to be developed (by the students) and assessed (by the teacher). Interviews with teachers indicated that this provided a distribution of workload amongst students (a group produces one product rather than each student creating a product) and saved the teacher time when correcting (due to the decrease in marking load). One of the teachers said: “Actually it helps me to save time correcting; we have a big number of students so it helps me” [Teacher D]. Another teacher said:

Assessment in groups is preferred to assessing work individually. Also it is easier for me when the student works within a group; if she doesn't understand the work she can understand from her friend so they explain to each other and work together. [Teacher A]

During the interviews, the case study teachers generally agreed that their students were more likely to enjoy working on laboratory assessments (experiments and investigations) than other tasks, such as enquiry. These feelings were also reflected in the teachers' journal entries. For example, one teacher wrote: “Experiment assessment tasks are more enjoyable [than other assessments such as tests or extended research tasks] for students because they can directly observe it, it's a direct result they can see; this is the real science” [Teacher F]. Another teacher said: “In experiments the steps are clear for them and they enjoy obtaining results” [Teacher A]. Another teacher said:

Encouragement [of each other] and effort increased, especially during lessons with experiments or research work. Students attend the lesson responsibly with their flash drives and are prepared... [students know that] the task will be assessed, therefore others are relying on them. There is a feeling of responsibility. [Teacher A]

One teacher said that research (enquiry) was one form of assessment which her students enjoyed working on as this gave the students a selection of topics and made the task more personal for them. On this point, she said:

... [The students like] to search, to collect [information, data], to meet with someone to conduct a survey or to collect data from different sources. They enjoy it. They like to see, among the data they have collected, what the result is because they are the ones working on it. It's unique: no one else is working on the same topic so they want to get the results and determine what they mean. Once I gave them [the students] the chance to select the research topic, it made it [the topic and information] relevant and interesting to the students. [Teacher F]

Many of the external assessments that students were required to complete (such as the External Measure of Student Achievement and final exams) were primarily focused on assessing their science knowledge and skills. All of the case study teachers felt that the cooperative learning teaching and learning approach was a good way for students to learn and build on a range of skills. One teacher wrote in the journal: "Students employ many skills such as leadership, communication, decision-making, critical thinking and creating" [Journal Entry, Teacher R].

Although the case-study teachers generally viewed group assessments as a positive aspect of cooperative learning, interviews and journal entries highlighted that there were some challenges related to assessing students in their cooperative learning groups. Some teachers reported in their journals that there were a number of students who depended on others to complete tasks (especially when the group roles were not enforced during the lesson). On this point, one of the teachers wrote "Some students were not cooperating or contributing to the group work" [Journal Entry, Teacher D]. Additionally, one teacher who was interviewed said:

Sometimes, one student will do more work [than the others in the group]. They get emotional over this and, in the end, when students submit the work [to be assessed], sometimes one student will say that she did the most work and that another student did no work. Or the

other student only researched but I printed.... I request that they all write at the front of the product what each of their specific roles were and what each of them contributed. I deduct marks for the students who do not contribute much and do not give girls the marks if they did not deserve them.... I allow students to work alone but I tell her that she will lose 4 marks for participation, so zero for cooperation. This mostly happens with groups that have lazy or irresponsible students in them. [Teacher A]

Teacher A also had found ways to overcome this challenge and to gain a better understanding of student skill levels:

I carry out the experiment tasks, one as individuals and one in a group. Sometimes only one or two students in the group answer the questions. As a teacher I am not able to understand what each student's skills are, whether she knows how to analyse the data, draw a graph or record the data in the table. For example some girls don't know how to draw a table and write the results in the table, so the group work does not allow me to assess this [individual student's skills]. I use at least one experiment which doesn't need to be graded for the purpose of identifying skill abilities. [Teacher A]

Another challenge experienced by the case study teachers, when assessing students in groups, was when students did not get along with members of their group. Even though having set group roles was positive in terms of keeping students on task, the assignment of roles was sometimes an issue in terms of unfair workload or effort made by individuals during assessment tasks. To this end, one of the teachers said: "They enjoyed working in their groups but sometimes they like to work as individuals because, if there is a mark for the task, some of the students take more of the load than the others and it is not fair to give all the same mark" [Teacher R].

Group assessments (such as team tests) were viewed by some of the teachers and their students (seen during lesson observations) to be unfair because, in some cases, individuals did not revise all of the content and only one student would answer the

questions, yet all of the students in the group would be assigned that grade. In a number of lessons, I observed members of some groups dividing revision work amongst themselves. On this point, one teacher explained that students might say:

You have this part, I have this part, and you have this part, so this is your responsibility if we have this question. If a student didn't answer a question [related to what she was supposed to study for] then they would blame her because she didn't study her assigned part. [Teacher N]

Many case study teachers felt that the use of team assessments (especially team tests) was a challenge because it did not provide a clear indication of the individual students' ability. When asked about group tests, one of the teachers said "No, I don't like it. Some students complain about the group exam. They don't like all the students to take the same mark because one student didn't study" [Teacher R]. Another said: "They sometimes rely [too much] on each other. For some of the girls, if they know they have a group exam, they won't study" [Teacher D].

Another case study teacher expressed that this problem was common and that, to overcome it, she would tell her students that there was an exam but they would not be told whether it was an individual or a group exam. She said "At the time of the exam they will find out whether it is an individual exam or team test, so they are encouraged to study everything" [Teacher F].

In contrast to the other case-study teachers, one felt that team tests were an opportunity to encourage group work and explained that, to ensure that her students revised, she made it clear that she would change the group placements during the assessment. This teacher explained:

I think that based on what ADEC is planning, the... [team tests] are not a real assessment from the point of view that we are evaluating their [student] knowledge as long as ... another chance for cooperation and working together and sharing information. That's why I am trying to address this issue by telling them [the students] not to guarantee that I

am going to put them together with the same group for the exam. I might change it. In this way I am trying to avoid their [student] plans.

[Teacher F]

Interestingly, some of the teachers reported that the use of team tests, as a form of assessment, was frowned upon by some parents or guardians who felt that group testing did not give them a clear indication of their child's understanding and knowledge of the topic being assessed. On this point, one of the teachers described her experiences with a parent:

I had a comment from one of the parents that, when I said this mark was for the team test, the mother didn't care about the mark. She said, "if it is a group task I don't care. It's not my daughter's level. I want something individual." [Teacher B]

Another problem related to assessment tasks was the students' low levels of English literacy. The students' English language skills were, generally, not adequate to search the internet or to find information in books. This lack of English prevented the students from looking up questions and finding answers during research assessment tasks. This issue was frequently encountered and, during one lesson observation, students regularly asked for clarification from both the teacher and their peers as they searched for information about the adaptations of animals. Although some students were able to enter the key words posed in the question into the search engine, many struggled to select the relevant information and subsequently were unable to read or comprehend the information. Reports in teachers' journals also reflected views about the research component of assessment tasks. As one teacher commented:

The students didn't like the enquiry task, collecting data and searching the websites, because they didn't understand what they should look for or they couldn't find enough information. The language barrier was difficult because the levels of English were low and most of the relevant information was in English. [Teacher A]

Assessing students in groups was found to have both benefits and challenges (such as students depending on their peers) which teachers are finding ways to address in a variety of ways, yet there are still some aspects that need to be overcome. In terms of benefits, the case study teachers reported that, in terms of assessment, the implementation of effective cooperative learning resulted in reduced workload for teachers and students, an increase in student responsibility and higher levels of student engagement on assessment tasks. However, a number of aspects related to assessment in cooperative learning posed challenges for the teachers. For example, team testing was deemed unfair and a poor indicator of student ability and was not highly regarded by some students, teachers and parents.

5.5 Resources

A major issue influencing effective cooperative learning implementation that was identified by all of the teachers was the lack of sufficient resources. Although the teachers were keen to incorporate experiments and investigations (laboratory work) as well as research tasks into their lessons, there were a variety of restrictions, including a lack of science equipment, and of information technology equipment and resources (books, stationary supplies, etc.). It was often difficult for teachers to gain access to the IT rooms for all of their classes and when they were able to book a lesson there, there were sometimes issues with the hardware (which might be faulty or inoperable) and internet connection. To overcome these issues, teachers would assign students the research tasks to be completed at home (losing out on an opportunity to implement cooperative learning in lessons) or would need to provide the information (the text from internet or books) themselves.

The lack (or limited amount) of resources and equipment was the source of much frustration for the case study teachers. It was common for teachers to only have adequate equipment supplied for four or five groups, when there were about nine or ten groups in each class. To this end, one of the teachers said that “limited IT access is a big challenge because part of cooperative learning is to do the group work and inquiry at school. If you don’t have the resources, our work is restricted because we don’t have access to all that we need” [Teacher N].

The case study teachers generally agreed that the least enjoyable aspect of the assessment tasks (for students) was the research tasks (searching for information electronically or via other sources including books, or obtaining information via interviewing teachers and students about topics of interest). Some of the students did not have internet access at home and access at school was often limited for various reasons, including poor connectivity due to the weather, or hardware issues. Ultimately, the teachers were required to have the information (text) pre-prepared for students. On many occasions, particular aspects of the topics being covered in science class (such as evolution) were not available in their textbooks or library books and not available in Arabic (there was limited information available on the internet), seriously restricting this opportunity for students to build on their research skills. Therefore, instead of students collecting the data themselves and building on their research skills, the practice of teachers providing students with the information shifted the activity from research to reading comprehension. Also, on several occasions, the school libraries would be closed (the librarian being absent or filling in for absent teachers), also restricting their use.

Other teachers commented on the lack of computers available for students to allow students to access the online resources. On this point, one teacher said:

There is difficulty in getting to use the online resources. I faced this problem. If I tried to manage it with the IT teacher, sometimes it was inapplicable, I could not engage my full schedule in her timetable. At the same time I tried to find another solution by allowing them to bring their I-pads and laptops, and we had big trouble with the administration in that semester so we were unable to use the online resources flexibly.
[Teacher F]

Another teacher explained how she overcame some of the IT issues she encountered:

In the topic on electromagnetic waves, I brought the information in for them, I photocopied the resources and I printed them out from websites and gave each group the information. Maybe they are not learning a

skill if they are not searching from the internet... I allow them to search and answer and discuss [from the supplied information] and then I begin to teach them the concepts. [Teacher A]

Insufficient science equipment for the whole class, coupled with a lack of knowledge about the handling/use of the equipment (on the part of the both teachers and laboratory technicians) hampered the inclusion of laboratory or research work in some science lessons. In some cases, teachers were not aware of the laboratory equipment that was available to them, and there was a general need for exemplars of tasks (experiments and investigations) for students to complete (rather than teachers creating or finding tasks themselves). As for the laboratory technicians, many did not have the proper training (some were teachers prior to becoming a laboratory technician) and were often not skilled to perform technical duties (such as diluting acids, operating and repairing equipment).

The teachers felt, to varying degrees, that the laboratory technicians did not provide adequate support during science practicals. Some laboratory technicians would prepare the equipment for teachers, but many technicians would not trial the equipment to check whether it worked, and would not be present during the lesson. On one occasion, I observed a lesson in which the teacher had ordered the relevant equipment (light bulbs, batteries, switches) for an experiment on electric circuits. During the experiment, students encountered many issues with the equipment, such as batteries without charge and blown light bulbs. The laboratory technician, on this occasion, was not available to replace these and, as a result, the teacher joined groups together, again disrupting the dynamics of the groups (as discussed earlier).

Teachers also felt that some laboratory technicians were not supportive when it came to preparing the requested number of sets of equipment even if additional sets were available. One teacher said:

The lab technicians said we have to prepare just for 4 or 5 groups as the maximum, most of the time it's for 4 only, not the 9 or 10 groups. Even if we have the equipment, they will only prepare for 4 or 5 groups. [Teacher N]

Classroom observations indicated that teachers' efforts to effectively incorporate cooperative learning strategies were frequently hampered by a lack of equipment. I observed, on a number of occasions, a lack of equipment forcing the teacher to join groups of students together so that they could share what was available. In doing so, these larger groups created a disruption to the group dynamics. I also observed many students crowding around one bench. Many of the students were observed to be looking on rather than being involved in the lessons, especially when compared to the lessons where there was sufficient equipment available. As a result, in lessons that lacked sufficient equipment, many students sat back in their chairs, disinterested in the laboratory work. One teacher confirmed this when she said:

There are not enough resources; sometimes in experiments [the resources] are not sufficient. The resources, such as books and IT (computers), also are not sufficient in number. The way that students are seated in both classrooms and laboratories is difficult as we cannot move around freely. For example, when the students are seated in the classroom it is difficult to organise students into three students in each group as the area in the classroom does not permit this to work effectively. [Teacher A]

These findings suggest that the general lack of information technology, reference book resources and laboratory equipment may have impacted on the teachers' ability to effectively implement cooperative teaching and learning strategies in science lessons. Some teachers reported that they were able to work their way around this issue; however, the lack of sufficient and suitable resources made their job difficult. Also, teachers felt that laboratory technicians were not knowledgeable about the equipment available and its mode of use, and that there was a lack of support in preparing sufficient equipment to cater for group numbers.

5.6 Chapter Summary

Qualitative data collected from the seven case study teachers was used to address the fifth research question: *What are the benefits and challenges of implementing*

cooperative learning as part of the teaching and learning process? Yin's (2011) five-phase cycle was employed to analyse the qualitative data collected from the case study teachers (interviews, observations, task samples, lesson plans and journals) to establish content and face validity. The four main themes which emerged were: increased cooperation and reduced behaviour problems; ability to cater for students of differing abilities; assessment; and resources. Overall, teachers viewed cooperative learning implementation as a positive aspect for themselves and their students. Cooperative learning gave teachers an opportunity to build on student skills through various activities and assessments.

All of the case study teachers agreed that, whilst there were many benefits of implementing cooperative learning in their science lessons, some aspects such as the lack of resources made the implementation a challenge. Although the teachers in this study were implementing cooperative learning to varying degrees, it is essential to highlight the benefits and challenges faced by the teachers who were implementing cooperative learning effectively. The various challenges, such as lack of resources and issues with assessment, may have impacted on the learning environment and attitude perceptions of students. Also, some teachers may not have been sufficiently trained in cooperative learning: many did not have any training; some teachers were not provided with proper support by their assigned advisor; and some teachers were not supported by colleagues and school administration. These may have all contributed, in one way or another, to the findings of this study.

The next chapter discusses the results and analyses and links the findings of this study to the theoretical literature and other research findings.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

6.1 Introduction

The study reported in this thesis employed a multistrand design in which quantitative and qualitative data were collected sequentially. The study involved two independent strands; one that utilised perception data collected from the students and the other that involved the collection of qualitative data from teachers. A triangulation design was employed for the purpose of enhancing the validity of the research findings (Creswell & Plano Clark, 2007).

The first strand involved the collection of data using two translated and modified questionnaires, the What Is Happening In this Class (WIHIC) questionnaire and the Attitudes towards Cooperative Learning (ACL) questionnaire. The instruments were administered to 784 students in 34 science classes. These classes were selected from grades 6 to 9 in eight Cycle 2 public high schools in Abu Dhabi, UAE. Four of the eight schools were all-male and four of the schools were all-female. All of the science teachers were required by the Abu Dhabi Education Council (ADEC) to be implementing cooperative learning strategies in science lessons. The selection of effective cooperative learning classes ($N=12$) and ineffective cooperative learning classes ($N=22$) was primarily dependent on whether the teacher was considered to be implementing cooperative learning in an exemplary way.

The second strand of the study involved the collection of qualitative data. This sample involved 17 female teachers, seven of whom were selected as case study teachers (Cresswell & Plano Clark, 2007). The selection of the seven case study teachers was purposive and was primarily dependent on whether the teachers had an established understanding of implementing cooperative learning, as evidenced through exemplary planning and delivery of lessons. Observations were carried out in the classrooms of all 17 teachers. The collection data from the seven case study

teachers included teacher journals, classroom observations, lesson plans, samples of activities and tasks and interviews. In-depth interviews with key informants and a focus group were conducted with the seven case study teachers to obtain feedback about the benefits and challenges of implementing cooperative learning.

This chapter concludes the study under the following headings:

- Summary and discussion of findings (Section 6.2)
- Limitations of the study (Section 6.3);
- Significance of the study (Section 6.4);
- Recommendations for future research (Section 6.5); and
- Final remarks (Section 6.6).

6.2 Summary and Discussion of Findings

This section, divided into five subsections (from 6.2.1 to 6.2.5), summarises and discusses the results for each of the five research questions posed in Chapter 1 (Section 1.4).

6.2.1 Research Question 1: Reliability and Validity of the Surveys

The first research question was:

Are modified and translated versions of the What Is Happening In this Class (WIHIC) and Attitudes towards Cooperative Learning (ACL) instruments, which assess students' perceptions of the learning environment, attitudes, motivation, engagement and aspirations, valid and reliable when used in the UAE?

Two modified and translated (Arabic/English) surveys were used to collect the quantitative data for the present study. The What Is Happening In this Class (WIHIC), developed by Fraser, Fisher and McRobbie (1996), was employed to assess students' perceptions of their learning environment (described in Section

3.5.1.1) and the newly-developed Attitudes towards Cooperative Learning (ACL) survey (modified from existing questionnaires) was used to assess students' motivation, attitudes and aspirations toward a career in science (described in Section 3.5.1.2). To establish confidence in subsequent results, the first research question sought to provide evidence for the reliability and validity of the WIHIC and ACL instruments. The construct validity of both the WIHIC and ACL instruments was guided by the framework suggested by Trochim and Donnelly (2006), which is described in Section 3.7.1.

The data collected from 784 students in 34 science classes in Abu Dhabi, UAE was analysed to determine the factor structure, reliability and internal consistency, ability to differentiate between classes, and to discriminate validity for both the WIHIC and ACL instruments. A summary of the results for the validity and reliability of the instruments is presented below.

6.2.1.1 *Validity and reliability of the WIHIC*

Given that the WIHIC is already a well-established learning environment instrument, its validation, for the purpose of this study, involved only the criterion-related factors from the construct validity framework suggested by Trochim and Donnelly (2006). The findings are summarised below.

- The factor loadings for each item had a factor loading of at least 0.40 on their own scale and less than 0.40 on the other four scales.
- The alpha coefficients for the five WIHIC scales ranged from 0.86 to 0.93, with the individual as the unit of analysis, and coefficients between 0.94 and 0.98 when the class mean was used as the unit of analysis. These reliability coefficients were all higher than Nunnally and Bernstein's (1994) minimum of 0.70 for satisfactory reliability.
- The ANOVA results were statistically significant ($p < 0.01$) for all five WIHIC scales. The η^2 values ranged from 0.13 to 0.26. These results suggest that

the Arabic version of the WIHIC was able to distinguish between the perceptions of students in different classes.

- The component correlation matrix, obtained from the oblique rotation, showed that the highest correlation was 0.62 and thus all values met the requirements of adequate discriminant validity (Brown, 2006).

The findings reported in this study were similar to those of other studies that used modified English versions of the WIHIC instrument in various countries and found it to be a reliable tool; namely, in: Australia (Dorman, 2008); Australia and Canada (Zandvliet & Fraser, 2004, 2005); Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008); India (Koul & Fisher, 2005, 2006); Uganda, Africa (Opolut-Okurut, 2010); New Zealand (Saunders & Fisher, 2006); South Africa (Aldridge et al., 2009) and the United States of America (den Brok, Fisher, Rickards, & Bull, 2006; Holding & Fraser, 2013; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; Pickett & Fraser, 2009; Wolf & Fraser, 2008).

Additionally, my results corroborate those of other studies that have found the WIHIC to be valid and reliable when used in languages other than English, including: Mandarin (Aldridge & Fraser, 2000); Korean (Kim, Fisher, & Fraser, 2000; Khine & Fisher, 2003); Bahasa Indonesian (Fraser, Aldridge, & Adolphe, 2010; Margianti, Fraser, & Aldridge, 2001; Wahyudi & Treagust, 2004); IsiZulu (Aldridge, Fraser, & Ntuli, 2009), Sepedi (Aldridge, Laugksch, Seopa, & Fraser, 2006); Arabic (Afari, Aldridge, Fraser, & Khine, 2013; MacLeod & Fraser, 2010); Spanish (Allen & Fraser, 2007; Robinson & Fraser, 2013); and Greek (Giallousi, Gialamas, Spyrellis, & Pavlaton, 2010).

Overall, the findings of this study provide evidence to support the reliability and validity of the Arabic/English version of the WIHIC instrument when used in the UAE context. Importantly, the findings were comparable to other Arabic versions of the WIHIC employed in studies by Afari et al. (2013), MacLeod and Fraser (2010) and Al Zubaidi, Aldridge, and Khine (2014).

The strong support for the reliability and validity of this Arabic version of the WIHIC suggests that the instrument can be used with confidence in future studies, and that the data was suitable for answering subsequent research questions.

6.2.1.2 *Validity and reliability of the ACL*

To overcome the well-known, important and long-standing problems identified by Kind, Jones & Barmby (2007) and related to many of the attitude scales developed in the past, care was taken when developing the ACL to ensure that:

- Conceptually different constructs were not combined to form one unidimensional scale;
- Clarity in the descriptions for the constructs to be measured was established;
- The construct validity was addressed in the data analysis; and
- Satisfactory reliability coefficients were obtained in the data analysis.

As with the WIHIC, Trochim and Donnelly's (2006) construct validity framework was used to validate the ACL items in terms of their convergent, discriminant, predictive and concurrent validity. The findings are summarised below.

- Three items were found to be problematic and were removed from further analysis, these being Item 11 for the self-regulation scale, Item 32 for the task value scale and Item 49 for the adoption of scientific attitudes scale.
- All but one of the remaining 61 items had a factor loading of at least 0.40 on its own scale and less than 0.40 on the other seven scales. The exception was Item 10 for the self-regulation which did not load above 0.40 on its own or any other scale. This item was retained, as its inclusion was found to strengthen the structure of the scale.
- The eigenvalues for different scales ranged from 1.18 to 19.37. These results supported the factorial validity of the ACL scales.

- The alpha coefficient ranged from 0.80 to 0.90 with the individual as the unit of analysis, and from 0.91 to 0.97 with the class mean as the unit of analysis for different scales.
- The ANOVA results were statistically significant ($p < 0.01$) for all eight scales. The η^2 values ranged from 0.12 to 0.23 for the different ACL scales.
- The highest component correlation matrix of the ACL scales was 0.47, and this value meets the requirements of acceptable discriminant validity, as recommended by Brown (2006).

The validity and reliability results obtained in this study were similar to those found by Velayutham, Aldridge and Fraser (2011) when they developed the SALES instrument. Similar findings are reported for scales adapted for this study from the SALES (including those used in the development of the ACL) and used in other studies (Al Zubaidi, Aldridge, & Khine, 2014; Liou & Kuo, 2014; Velayutham & Aldridge, 2013; Yetisir & Ceylan, 2015).

Overall, evidence suggested that the Arabic/English ACL was valid and reliable when used in the UAE context. In all cases, students were able to explain their response choices for the survey items and were able to provide examples for their choice of response. It is recommended, however, that future research further establishes the applicability of the ACL in other contexts (*Recommendation 1*).

Thus, my findings suggest that the data collected using both the WIHIC and ACL instruments was suitable to answer the subsequent research questions.

6.2.2 Research Question 2: Learning Environment-Attitude Associations

The second research question was:

What relationships exist between students' perceptions of a cooperative learning environment and their:

- a. Attitudes towards science;
- b. Motivation and engagement in science; and
- c. Science-related aspirations?

To address the second research question, simple and multiple correlation analysis was used with data collected from the 784 students. Simple correlation analysis was used to examine the bivariate relationships between each attitude and learning environment scale. Multiple correlation analysis was undertaken using the set of five scales of the WIHIC questionnaire as independent variables and each attitude scale as the dependent variable. To identify which of the individual learning environment scales were significant independent predictors of student attitudes, the standardised regression weights (β) were examined (reported in Chapter 4, Section 4.3). The results are summarised below.

- The results of the simple correlations indicated that all five WIHIC scales were statistically significantly ($p < 0.01$) and positively related to each of the eight attitude outcomes (self-efficacy, self-regulation, learning goal orientation, task value, social implications, engagement, adoption of scientific attitudes, and science career aspirations).
- The multiple correlations were positive and statistically significant ($p < 0.01$) for all eight attitude outcomes, and ranged from 0.40 to 0.49 for the eight attitude outcomes.
- To identify which of the learning environment scales contributed to the variance in students' attitudes, the standardised regression weights (β) were examined. The results are summarised for each of the learning environment scales.
 - *Student cohesiveness*: Examination of the standardised regression weights (β) indicated that student cohesiveness was a statistically significant ($p < 0.01$) independent predictor of four of the eight attitude outcomes: learning goal orientation, task value, social implications and science career aspirations. All of the significant correlations were

positive in direction, suggesting that if students are given opportunities to get acquainted and to help and support one another, then they are more likely to have improved attitudes for these scales.

- *Teacher support*: The findings suggest that teacher support was a significant ($p < 0.01$) independent predictor of seven of the eight attitude outcomes, the exception being engagement. All of the significant correlations were positive, suggesting that teachers wishing to improve student attitudes should examine their interpersonal relationships with students and consider showing interest in students' problems, befriending and assisting them.
- *Involvement*: The standardised regression weights (β) indicated that involvement was a significant ($p < 0.01$) independent predictor of five of the eight attitude outcomes: self-efficacy, self-regulation, task value, engagement and science career aspirations. All of the significant correlations were positive, suggesting that if teachers increase student involvement in lessons, then it is likely that the outcome will positively influence the five attitude scales listed above.
- *Cooperation*: The findings suggest that cooperation was a significant ($p < 0.05$) independent predictor of six of the eight attitude outcomes: self-efficacy, learning goal orientation, task value, social implications, engagement and adoption of scientific attitudes. All of the significant correlations were positive, suggesting that increased student cooperation in lessons positively influences their attitudes.
- *Equity*: The findings suggest that equity was a significant ($p < 0.01$) independent predictor of all eight attitude outcomes. All of the significant correlations were positive, suggesting that teachers wishing to improve student attitudes are encouraged to treat students in a way that is perceived to be fair.

The results found that all five WIHIC scales were statistically significantly and positively different to the eight attitude outcomes. These findings were consistent with the findings of many past studies, which report that students taught using a cooperative learning approach (compared with a conventional learning approach) were likely to have improved attitudes towards science lessons (Akinbobola, 2009; Arslan, Bora, & Samanci, 2006; Campisi & Finn, 2011; Demir, 2008; Demirci, 2010; Hong, 2010; Kincal, Ergul, & Timur, 2007; Korkut-Owen, Owen, & Ballestero, 2009; Kose, Sahin, Ergun, & Gezer, 2010; Looi, Chen, & Ng, 2010; Martin-Dunlop & Fraser, 2008, Sung & Hwang, 2013).

My findings were also consistent with studies that have investigated associations between involvement and self-efficacy. For example, a cross-sectional study investigating the associations between students' self-efficacy and their involvement in learning science was carried out in Taiwan by Hong and Lin (2013), who found that students with more involvement in science learning scored significantly higher for self-efficacy than those with less involvement.

My findings corroborate past studies that have examined the cooperative learning environment and reported improved student motivation towards science (Freeman, Alston, & Winborne, 2008; Moebius-Clune, Elsevier, Crawford, Trautmann, Schindelbeck, & Van Es, 2011). For example, Freeman, Alston, and Winborne (2008) found that there was a positive influence of learning communities (collaborative learning) on students' attitudes, learning experiences and intrinsic motivation in Science, Technology, Engineering and Mathematics (STEM). Further, Moebius-Clune et al. (2011) found that, during enquiry-based teaching, students were motivated and substantively engaged. Kirik and Boz (2012) and Foster (1985) report that, when compared to traditional instruction, cooperative learning improved students' motivation to study chemistry. Similar to my findings, in a study involving students exposed to cooperative learning conditions, students were found to demonstrate higher academic self-esteem and greater social cohesion (Johnson, Johnson, & Taylor, 1993).

With respect to science career aspirations, the findings of this study corroborate those of past research studies by Duran, Hoft, Lawson, Medjahed, and Orady (2014) and

House (2009). Furthermore, House (2009) found that students involved in activities associated with cooperative learning, such as using active learning strategies, showed positive interest in a science career. Conversely, students who reported that they more frequently listened to the teacher give a lecture-style presentation during science lessons tended to have less interest in a science career.

The results indicate that students' perceptions of the learning environment influence their attitudes, in particular, self-efficacy and science career aspirations. This study has contributed to these areas of the literature, specifically on the reform efforts underway in the UAE context. Given these findings, it is recommended that education reform efforts, similar to those examined in this study, consider the importance of providing teachers with the knowledge of how to improve the learning environment in science classes, in order to improve student attitudes towards science learning (*Recommendation 2*). Further, it is recommended that teachers who wish to see an improvement in student attitudes look for ways to include more student cohesiveness, teacher support and involvement in their classes (*Recommendation 3*). Thus, students taught using a cooperative learning approach (compared with a traditional learning approach) are likely to have improved attitudes towards science lessons. This is an important finding to inform future decisions in the UAE context.

6.2.3 Research Question 3: Differences in the Learning Environment and Attitudes

The third research question was:

Do differences exist for students in classes in which cooperative learning strategies are implemented effectively and those who are not, in terms of:

- a. Perceptions of the learning environment;*
- b. Attitudes towards science;*
- c. Motivation and engagement in science; and*
- d. Science-related aspirations?*

To answer this question, one-way multivariate analysis of variance (MANOVA) and effect sizes was used. For the MANOVA, the five WIHIC scales and eight attitude scales were used as the dependent variables and the instruction type (use of effective cooperative learning or not) was used as the independent variable. In addition, the effect size for each scale was calculated, to determine whether these differences might be educationally significant (as recommended by Thompson, 2002).

The results indicate that:

- For the learning environment scales, there were two statistically significant differences for students who were exposed to cooperative learning and those who were not for the teacher support (effect size=0.21 standard deviations) and cooperation (effect size=0.15 standard deviations) scales. Thus, for teacher support, the students in the effective cooperative learning classes scored lower than their counterparts not exposed to effective cooperative learning. Conversely, the classes exposed to effective cooperative learning scored higher for cooperation than those who were not so exposed.
- For the attitude scales, statistically significant ($p < 0.05$) differences were found for three of the eight scales: self-efficacy (effect size=0.18 standard deviations), task value (effect size=0.29 standard deviations) and science career aspirations (effect size=0.21 standard deviations). In all cases, students exposed to effective cooperative learning scored higher for these constructs than did students who were not.
- The effect sizes for those scales with statistically significant differences were considered to be ‘medium’ in effect, according to Cohen’s (1992) criteria.

These findings indicate that when compared to classes in which cooperative learning was not well implemented, the use of cooperative learning strategies improved students’: self-confidence and belief in their ability to perform tasks (self-efficacy); perceptions of the science tasks as interesting, important and useful (task value); and their interest in a career in science (science career aspirations). In classes where cooperative learning was implemented effectively (compared to the classes in which

cooperative learning was not implemented effectively) students also felt that they were cooperating with each other during activities (cooperation).

Interestingly, the students in classes where cooperative learning was implemented effectively scored lower for teacher support than their counterparts in classes that did not. This could be due to the increase in independence given to students in cooperative learning classes. Thus, teachers in classes not exposed to cooperative learning were found to be more supportive.

Supporting the findings of this study, the following studies have also examined a cooperative learning environment and reported improvements in: students' self-efficacy (Liu, Lin & Chang, 2010; Meij, Meij, and Harmsen, 2015); the extent to which students value the tasks given (Bartle, Dook, & Mocerino, 2011; Townsend & Hicks, 1997); students' adoption of scientific attitudes (Day & Bryce, 2013; Fang, 2013); and their science career aspirations (Duran, Hoft, Lawson, Medjahed, & Orady, 2014; Koul, Lerdpornkulrat, & Chantara, 2011). Further, Wang (2012) reported that female college students, taught using a cooperative learning approach, showed improved achievement motivation when compared with a traditional learning approach.

Contrary to my findings, which indicated improved motivation and self-efficacy, Schachar and Fischer (2004) reported a decline in motivation in the cooperative learning group when compared with the control group. Additionally, a study by Meluso, Zheng, Spires, and Lester (2012) investigated the effects of collaborative and single game player conditions on science content learning and science self-efficacy. Results indicated that there were no differences between the two playing conditions.

This study extends the literature and adds to the existing findings in terms of examining how cooperative learning might be an effective means of improving students' attitudes towards science. Given that past research related to cooperative learning has been carried out in Western contexts, this study has extended the literature to examine students' perceptions of the learning environment and their attitudes to science classes in a Middle Eastern context, the UAE.

6.2.4 *Research Question 4: Differential Effectiveness of Cooperative Learning*

The fourth research question was:

Is exposure to cooperative learning differentially effective for male and female students in terms of their perceptions of the classroom learning environment and attitudes towards science?

To address this question, a two-way multivariate analysis of variance (MANOVA) was used, whereby the independent variables were students' exposure to cooperative learning, and student sex, and the dependent variables were the five WIHIC and eight ACL scales. Because the two-way MANOVA yielded statistically significant results overall for each of the three effects (exposure to cooperative learning, sex, and exposure to cooperative learning versus sex), the univariate ANOVA was interpreted for each dependent variable for each of the three effects. The results for method of instruction, student sex and the interaction between the method of instruction and student sex are summarised below.

- *Method of instruction (exposure to cooperative learning strategies):* The results for the two-way MANOVA (with control for gender) indicated that teacher support was the only learning environment scale, and self-efficacy, task value and science career aspirations were the only attitude scales, for which there were statistically significant ($p < 0.01$) differences between the method of instruction.
- *Student sex:* This portion of the MANOVA/ANOVA focused on whether differences existed between males and females, regardless of the exposure to cooperative learning. Statistically significant ($p < 0.05$) differences were found between males and females for student cohesiveness, teacher support, cooperation, self-efficacy, task value, engagement and science career aspirations. The proportion of variance for these significant differences (η^2) ranged from 0.01 to 0.04.

- *Interaction between method of instruction and sex:* The results indicated that there were no statistically significant interactions between the method of instruction and sex for any of the learning environment scales but that there was a statistically significant interaction for six of the eight attitude scales (the exceptions being learning goal orientation and social implications). Therefore the independent interpretations of exposure to cooperative learning differences and sex differences are valid only for the five learning environment scales and the three attitude scales mentioned above.
 - The amount of variance accounted for by the statistically significant ($p < 0.05$) interactions between exposure to effective cooperative learning strategies and sex (in terms of η^2 statistic) was 0.01 for self-efficacy, 0.02 for task value and self-regulation and 0.01 for engagement, adoption of scientific attitudes and science career aspirations.
 - The interpretation of the interactions ($p < 0.05$) for self-regulation, engagement and adoption of scientific attitudes was that, in classes that were not exposed to cooperative learning and in classes that were exposed to cooperative learning, males held more positive attitudes than females.
 - The interpretation of the significant interactions ($p < 0.05$) for self-efficacy, task value and science career aspirations was that in classes that were exposed to effective cooperative learning strategies, males and females had similar attitudes. However, in classes which were not exposed to effective cooperative learning strategies males held more positive attitudes than did their female counterparts.

My findings, which indicated that females exposed to effective cooperative learning held more positive attitudes than males, corroborated past research. For example, my findings support those of Ruiz, Graupera, Moreno, and Rico (2010) who reported that girls were less competitive and individualistic than boys, and more cooperative

and affiliative. Also, Opdecam, Everaert, Van Keer, and Buysschaert (2014) found that female students preferred team learning, and male students were more likely to prefer lecture-based learning. Past studies in higher education have also found that female students prefer cooperative learning methods more than males do (Anderson & Adams, 1992, Lundeberg & Moch, 1995). Further, a study by Cabrera, Nora, Crissman, Terenzini, Bernal, and Pascarella (2002) found that females prefer cooperative learning techniques because this pedagogy matches their way of learning, while males prefer traditional lecture techniques, given their more analytical, individualistic, and competitive approach to learning.

My findings contradict a number of past studies. For example, Moffat et al. (1992) found that, in a student-centred cooperative learning environment, males reported more positive attitudes towards science than did females. Similarly, Naugah and Watts (2013) found that if there was little opportunity for collaborative or activity-based learning, females were likely to be alienated from science.

My findings also contradicted the findings of Bogar, Kalender, and Sarikaya (2012) and Nausheen, Alvi, Munir, and Anwar (2013) who reported that there was no difference between female and male students' attitudes towards a cooperative learning environment. Further, my findings contradicted the findings of Gernigon, d'Arripe-Longueville, Debove, and Puvis (2003) who found no gender differences for the level of self-efficacy in students. My findings suggest that contrary to males, females were more engaged in classes exposed to cooperative learning and less engaged in classes where cooperative learning was not implemented effectively.

Statistically significant interactions between the method of instruction and sex was found for science career aspirations. Contradicting my findings, Belanger and Peters' (2008) study involving middle school students indicated that even though students felt that a career in science would be difficult or boring, 22 out of the 40 students also expressed that they would consider a career in science.

As a female researcher in the UAE, it was not possible to observe male classes at the time of carrying out this study. Given the differences between males and females found in this study, it is recommended that future studies examine whether the

differences are a result of the quality of the cooperative learning and teaching that is being carried out in the male schools (males are taught separately to females in the UAE) or male-female preferences towards different ways of learning (*Recommendation 4*).

Despite this limitation, my findings suggest that policy developers and curriculum reformers in the UAE should be aware of the gender differences which exist, and that the use of cooperative learning is differentially effective for gender, in this case favouring females. Therefore, this study has contributed to the literature in the areas of gender differences, in terms of perceptions of the learning environment and attitudes towards science, and highlights the need to better cater for cooperative learning strategies with male students in an effort to improve their attitudes towards science.

6.2.5 Research Question 5: Benefits and Challenges

The fifth research question was:

What are the benefits and challenges of implementing cooperative learning as part of the teaching and learning process?

To examine what benefits and challenges female teachers encountered whilst implementing the cooperative learning teaching and learning approach, qualitative information (teacher journal, classroom observations, interviews with case study teachers, samples of activities and tasks and lesson plans) from seven case study teachers was gathered and analysed. The five-phased cycle suggested by Yin (2011) was used when analysing the qualitative data in this study.

The findings from the four main themes which emerged following the analysis of the qualitative data are summarised below.

Theme One: Increased cooperation and reduced behaviour problems

- When compared to classes that were not using cooperative learning strategies, the effective implementation of cooperative learning in science lessons resulted in enhanced cooperation and communication between students.
- Teachers felt that, in classes using cooperative learning, when compared to those that were not, students were generally more engaged and there were fewer off-task behaviours and behaviour problems.
- Some students, for various reasons, were unable to fulfil their assigned roles and needed support to carry out their assigned duties.

My findings, with respect to the differences experienced by the case study teachers, generally reflected student responses to the surveys. The survey results indicated that there were statistically significant ($p < 0.05$) differences for students who were exposed to cooperative learning and those who were not, for two learning environment scales (teacher support and cooperation), and for four attitude scales (self-efficacy, engagement, task value and science career aspirations). These qualitative findings support the quantitative findings, whereby teachers reported that the use of cooperative learning increased the levels of cooperation and engagement in science lessons.

It is likely that these findings will have impacted on students' perceptions of the learning environment and their attitudes. For example, if cooperative strategies were implemented effectively by teachers, then students might perceive increased levels of cooperation amongst their peers (cooperation), increased involvement in activities and tasks (engagement), and an understanding and mastering of science concepts and skills (learning goal orientation).

Theme Two: Ability to cater for students of differing abilities

- In comparison to when teachers were not implementing cooperative learning, the use of cooperative learning strategies during science lessons enabled teachers to cater for different abilities. Teachers were better able to support weaker and special needs students, could challenge gifted and talented students through differentiated tasks, and were able to have the gifted and talented students support those of weaker ability.
- When students were grouped according to students' abilities, the groupings provided a means for teachers to cater for different abilities in science lessons.
- Analysis of work samples related to investigation tasks further supported the notion that the use of groups helped teachers to cater for students of differing abilities by differentiating the written worksheets.

It is possible that these findings reported by the teachers also impacted on students' perceptions of the learning environment and their attitudes (as described in section 4.3). It is likely that if a teacher was better able to cater for students' needs by using effective cooperative learning strategies, then the students might perceive the teacher to be more supportive (teachers' support). It is also plausible that a teacher's ability to cater for learners differently would improve students' beliefs in their ability to succeed (self-efficacy) and their sense of engagement in science activities (engagement).

Similar to my findings, past studies provide evidence to suggest that structured group roles work better than unstructured groups. When group roles were not assigned, spontaneously occurring roles fluctuate (Lumpe & Staver, 1995). Corroborating my findings, Gillies (2003a, 2008) investigated structured groups and found, not only gains in learning, but also changes in behaviour and the quality of discourse and interaction.

Theme Three: Assessment

In terms of assessment, analysis of the qualitative data indicated that although there were a number of benefits, there were also some disadvantages for both the teachers and the students when teachers implemented cooperative learning strategies. These are summarised below.

- The results indicate that when cooperative learning was implemented (compared to lessons where cooperative learning was not part of the teaching and learning), there was increased student responsibility (students assigned group roles with responsibilities) and higher levels of student engagement.
- The reduced workload, whereby only one product for each group of students was required to be developed (by the students) and assessed (by the teacher), allowed a distribution of workload amongst students (with a group producing one product rather than each student creating a product) and saved the teacher time (due to the decrease in marking load).
- Students appeared to enjoy working on laboratory assessments (experiments and investigations) more than they did on other assessment-related tasks.
- Teachers felt that the cooperative learning teaching and learning approach was a good way for students to learn and build on a range of skills.
- Teachers reported that there were some students who depended on others to complete tasks (especially when the group roles were not enforced during the lesson), and it was challenging for teachers when some students did not get along with the other members of their group.
- Group assessments (such as team tests) were viewed by some teachers and their students (as seen during lesson observations) to be unfair because this method did not provide a clear indication of the individual students' ability. Also, in some cases, individuals did not revise all of the content (relying on

their peers) and only one student would answer the questions, yet all of the students in the group would be assigned that grade.

- Some teachers reported that the use of team tests as one form of assessment was frowned upon by some parents/guardians who felt that group testing did not give them a clear indication of their child's understanding and knowledge of the topic being assessed.

Overall, the case study teachers reported that, in terms of assessment, the implementation of effective cooperative learning reduced the workload for teachers and students, increased student responsibility, and encouraged higher levels of student engagement. However, teachers saw team testing as unfair and a poor indicator of student ability. It would appear that overall, team testing was not highly regarded by some of the students, teachers and parents. These results supported those of Kagan (1995), who examined the negative consequences of group grades and reported that they were unfair and made report cards less meaningful, undermined motivation, conveyed the wrong message, violated individual accountability, and created parental resistance to cooperative learning.

Although group assessment of students presented a number of challenges (such as students depending on their peers), the teachers were actively seeking ways to address these. There are still a number of challenges in this method of assessment. Therefore it is recommended that future reform projects consider and address the problems associated with group assessment methods, in particular, regarding the concerns of parents and teachers, before implementing changes (*Recommendation 5*).

Theme Four: Resources

A major issue identified by all of the teachers in regard to the effective implementation of cooperative learning was the lack of sufficient resources. Although the teachers were keen to incorporate laboratory work and research tasks into their lessons, there was a range of restrictions, including a lack of science and

information technology (IT) equipment and resources (books, stationary supplies, etc.).

- It was often difficult for teachers to gain access to the IT rooms, and when they were able to, there were frequently issues with the hardware (which might be faulty or inoperable) and internet connection. To overcome these issues, teachers would assign tasks for students to complete at home (losing out on an opportunity to implement cooperative learning in lessons) or had to provide the information (the text from internet or books) themselves.
- The lack (or limited amount) of resources and science equipment was the source of much frustration. It was common for teachers to have only enough equipment for four or five groups when there were nine or ten groups in each class. In these cases, groups had to be combined to accommodate the lack of equipment, thus disrupting the group dynamics. On these occasions, students were observed to be looking on rather than being involved in the practical component of the lesson.
- A lack of knowledge about the handling/use of the equipment (on the part of both the teachers and the laboratory technicians) hampered the inclusion of laboratory or research work in some science lessons. Many laboratory technicians lacked proper training (some were teachers prior to becoming a laboratory technician) and were not skilled to perform technical duties (such as diluting acids, operating and repairing equipment, etc.).
- On several occasions, the school library was closed (the librarian being absent or filling in for absent teachers), restricting its use.
- The teachers felt, to varying degrees, that the laboratory technicians did not provide adequate support during science practical lessons, did not check whether equipment was in working condition, and some were not willing to prepare the requested number of sets of equipment (even if additional sets were available).

- Many of the teachers may not have been sufficiently trained in cooperative learning, many did not have any training, some teachers were not provided with proper support by their assigned advisor, and some teachers were not supported by colleagues and school administration.

These findings suggested that lack of access to information technology, reference book resources and laboratory equipment may have impacted on the teachers' ability to effectively implement cooperative learning teaching and learning strategies in science lessons. Although some teachers were able to work their way around this issue, the lack of sufficient and suitable resources made the teachers' jobs difficult. Also, teachers felt that laboratory technicians were not were knowledgeable about the equipment available and its mode of use, and that there was a lack of support in terms of preparing sufficient equipment to cater for group numbers.

A lack of equipment can create situations in which group work cannot be carried out successfully. As a result of my findings, it is recommended that for cooperative learning to be implemented successfully, sufficient equipment be supplied to teachers to encourage them to integrate more laboratory work (*Recommendation 6*). It is also a recommendation that laboratory technicians be properly trained in all areas of the science laboratory to provide the relevant support to teachers (*Recommendation 7*). Furthermore, to ensure teachers are able to implement effective cooperative learning, ongoing access to the library and internet needs to be readily available for teachers and students (*Recommendation 8*).

It is possible that these shortcomings might have impacted on students' perceptions of the learning environment and their attitudes. It would seem likely that, if sufficient resources were available to teachers, as well as trained laboratory technicians to support the implementation of effective cooperative learning strategies, then students might have been more involved in activities and tasks (involvement). Furthermore, the availability of sufficient resources may have indirectly affected student attitudes, in terms of the degree to which they perceived themselves to be participating in science classes for the purpose of learning, understanding and mastering science concepts and improving skills (learning goal

orientation), as well as the degree to which they were involved in activities and tasks (engagement).

Past research suggests that, although there are challenges involved in implementing cooperative learning, the benefits outweigh these. Cooperative learning requires attention to student group construction (Millis, 2002), with heterogeneous, instructor-assigned groups of four students rated as the most effective (Lou et al., 2002). Contrary to other researcher's suggestions, the students in this study were often assigned to homogeneous groups (especially during assessments), which may also have impacted on the findings. It is recommended, therefore, that future studies examine whether students in science classes in Abu Dhabi fare better when grouped heterogeneously rather than homogeneously (*Recommendation 9*).

As Gundara and Namrata (2008) argue, cooperative learning will remain a field that engages well-meaning educators, but it will just be an ineffective or sporadic experience if it is not integrated into the functioning of the school and the curriculum. Research findings suggest that, although teacher training has been given more attention in the process of translating cooperative learning into the classroom, it is putting cooperative learning strategies into practice that is more complicated than initially expected (Cohen, 2004; Sahlberg, 2010; Sharan, 2010). The lack of proper training and support provided to teachers is another factor which could have impacted on their efforts to implement effective cooperative learning in science classes in the UAE. Many teachers were known to implement cooperative learning strategies into science lessons only when they knew they would be observed by a member of the senior leadership team or advisor. Thus, it is recommended that professional development be provided to teachers on an ongoing basis to ensure that they feel confident to implement cooperative learning strategies as prescribed by ADEC (*Recommendation 10*).

As an education advisor in some of the sample schools in this study, I observed firsthand a high level of frustration in teachers when they were implementing cooperative learning in science classes. These included some of the themes discussed above, including issues with assessment and lack of resources, which many of us did not have any control over at school level. Corroborating my findings, in a study

examining the implementation of complex instruction (a branch of cooperative learning), Pescarmona (2011) reports that teachers often reported feelings of doubt and frustration with the new way of teaching. Teachers often complained about the pressure caused by having to follow a vast syllabus, the difficult relationship with colleagues, the rigid school timetable and the lack of materials. Although it was not part of this research, it is possible that the lack of resources may have impacted on students' perceptions of the learning environment. It is recommended, therefore, that further research into issues identified by teachers as impacting on the implementation of cooperative learning (such as the lack of resources) be conducted from the students' perspective (*Recommendation 11*). Ideally, these issues should be addressed before introducing it into schools as part of a reform effort (*Recommendation 12*).

6.3 Limitations of the Study

As with any research involving humans, this study was not free of limitations. This section recognises their presence in this study and provides recommendations on the measures which can be instigated to minimise their effects in future studies.

Although rigorous validity analyses, using Trochim and Donnelly's (2006) construct validity framework, were carried out in this study, this study used exploratory factor analysis to examine the factor structure. It is recommended, therefore, that to provide additional evidence for the validity of the WIHIC, future research studies consider using confirmatory factor analysis to further establish the validity of the WIHIC (*Recommendation 13*).

Purposive sampling was used to carefully select the teachers in the qualitative component, to ensure they had an established understanding of implementing cooperative learning strategies (as evidenced through regular observations of exemplary planning and delivery of lessons). However, male teachers were not included, because regular, ongoing access into male schools was not feasible in the UAE context. It is recommended, therefore, that similar studies be carried out in a cross-section of both male and female schools to increase the generalisability of the findings (*Recommendation 14*). Further, a longitudinal study would help to

determine whether continued exposure to cooperative learning increases the number of students who choose science-related courses after their secondary education (*Recommendation 15*).

The sample for the present study involved only students from Cycle 2 or middle schools, therefore generalisations to the other grade levels should be made with caution. It is recommended, therefore, that future studies consider selection to include students in grades 10, 11 and 12; such a sample would make comparisons between Cycle 2 and Cycle 3 schools possible (*Recommendation 16*).

Since the data for the present study was gathered from eight schools within Abu Dhabi city, generalising the findings to include schools in outer regional Abu Dhabi and to other emirates should be done with caution. It is recommended, therefore, that future studies involve a larger and wider sample of students, both nationally and internationally (*Recommendation 17*).

Although this study investigated the impact of cooperative learning on a range of student outcomes that are considered important in science learning (including attitudes, self-efficacy, motivation and science career aspirations) it did not include achievement. It is recommended, therefore, that to add weight to future studies, they include achievement as an outcome measure of the effects of cooperative learning on attitudes in science (*Recommendation 18*).

The personal interpretation of interview data can impact on the data generated (especially when the researcher was also the advisor in the female schools which were studied) and could lead to bias. The researcher determines how long to remain in the field, whether the data are saturated to establish good themes or categories, and how the data evolves into a persuasive narrative (Cresswell & Miller, 2000). Patton (1980) describes this process as one where qualitative analysts return to their data 'over and over again to see if the constructs, categories, explanations and interpretations make sense' (p. 339). Every effort was made to acknowledge any bias and avoid having an impact on the data throughout this study. However, to provide further data for triangulation, in addition to the teacher interviews, future studies

could include student interviews to further establish relationships and clarification between the quantitative and qualitative data (*Recommendation 19*).

Unequal power in this study existed in terms of the relationship between the participants (students and teachers) and myself (researcher and advisor). Bloor (2010) notes that research methodology should consistently and consciously reflect the interconnectedness between researchers and participants, aiming for ‘power with’ approaches in research rather than ‘power over’. Although every effort was made to reduce the power relationship (by reassuring the participants of confidentiality both verbally and in writing) it is acknowledged that participants may not have been totally open/honest in their responses to questions during the interviews and when completing the surveys. This could be for a variety of reasons, such as fear of being identified and judged, or, in the case of the teachers, not wanting to admit to mistakes or errors they may have made whilst implementing cooperative learning strategies. Given this possibility, it is recommended that, for teachers, future studies incorporate the use of surveys (as well as interviews) so that teachers can report on their experiences anonymously to help to verify the qualitative responses (*Recommendation 20*).

The quantitative and qualitative data collected to address the research questions in this study were from science classes in Abu Dhabi, UAE. It is recommended that future studies investigating student attitudes in a cooperative learning environment include other subjects, such as English and mathematics (*Recommendation 21*).

6.4 Recommendations for Future Research

This section provides a list of recommendations to other researchers who wish to carry out similar studies.

Recommendation 1: As the ACL is a newly developed instrument, it is recommended that future research further establish the applicability of the instrument in other contexts.

- Recommendation 2:* Education reform efforts, similar to those examined in this study, should consider the importance of providing teachers with knowledge of how to improve the learning environment in science classes in order to improve student attitudes towards science learning.
- Recommendation 3:* The promising findings from this study suggest that teachers who wish to see an improvement in student attitudes should expose their students to a cooperative learning environment in science and other subjects and look for ways to include more student cohesiveness, teacher support and involvement in their classes.
- Recommendation 4:* Given the male-female differences found in this study, future studies could examine whether these results are related to the quality of the cooperative learning and teaching that is being carried out in the male schools (males are taught separately to females in the UAE) or male-female preferences for different ways of learning.
- Recommendation 5:* Future reform projects should consider parental views and address the problems associated with group assessment methods before implementing changes.
- Recommendation 6:* A lack of equipment can create situations in which group work cannot be carried out successfully; therefore, for cooperative learning to be implemented successfully, sufficient equipment needs to be supplied to teachers to encourage them to integrate more laboratory work.
- Recommendation 7:* Laboratory technicians need to be properly trained in all areas of science laboratory to enable them to provide the required support to teachers.

Recommendation 8: To ensure teachers are able to effectively implement cooperative learning, there needs to be ongoing access to the library and internet.

Recommendation 9: Given that other studies have found that heterogeneous, instructor-assigned groups of four students tend to be the most effective, future studies should examine whether students in science classes in Abu Dhabi fare better when grouped heterogeneously (rather than homogeneously).

Recommendation 10: To ensure all teachers are confident to effectively implement cooperative learning strategies as prescribed by ADEC, professional development be provided to teachers on an ongoing basis.

Recommendation 11: Further research, related to issues identified by teachers as impacting on the implementation of cooperative learning (such as the lack of resources), should be examined from the students' perspective.

Recommendation 12: Ideally, the issues identified by teachers in my research should be addressed before introducing cooperative learning into schools as part of the reform effort.

Recommendation 13: To provide additional evidence for the validity of the WIHIC, future research could consider using confirmatory factor analysis.

Recommendation 14: Since the qualitative component of this study could only be carried out in female schools, it is recommended that similar studies be carried out in a cross-section of both male and female schools to increase the generalisability of the findings.

Recommendation 15: A longitudinal study could be used to help to determine whether continued exposure to cooperative learning increases the number of students choosing science-related courses post-secondary education.

Recommendation 16: The sample for the present study involved only students from Cycle 2 (middle) schools; therefore, generalisations to the other grade levels should be made with caution. Future studies could consider selection to include students in grades 10, 11 and 12 (Cycle 3). Such a sample would make comparisons between Cycle 2 and Cycle 3 schools possible.

Recommendation 17: Future researchers who replicate this study could involve a larger and wider sample of students, both nationally and internationally to improve the external validity of the study.

Recommendation 18: To add weight to future studies, they could include achievement as an outcome measure of the effects of cooperative learning on attitudes in science.

Recommendation 19: To provide further data for triangulation, future studies could include student interviews to further establish relationships and clarification between the quantitative and qualitative data.

Recommendation 20: Teacher surveys (as well as interviews) could be incorporated to allow teachers to report on their experiences anonymously, to help to verify the qualitative responses.

Recommendation 21: The data collected in this study to address the research questions was from science classes in Abu Dhabi. Future studies investigating student attitudes in a cooperative learning environment could include other subjects, such as English and mathematics.

6.5 Significance of the Study

This study has extended the field of learning environments research, as it is one of the first studies of its kind to examine the impact of cooperative learning in science classes on a range of student outcomes (attitudes, motivation, engagement and science career aspirations) in Abu Dhabi, UAE. Specifically, this study has contributed to the literature on sex differences in terms of the impact cooperative learning in science has on attitudes, motivation and engagement in science and science career aspirations of students. This study is significant to a range of stakeholders and has built and extended on past research in the field of learning environments in a number of ways, discussed in detail below.

Methodologically, this study could be of significance to other researchers who might benefit from the availability of an Arabic version of the modified WIHIC for use in other studies. Also, the study makes available a reliable survey in both English and Arabic to assess students' attitudes towards cooperative learning. The ACL overcomes many of the problems of previous attitude surveys and can be translated, modified and used in many subjects. Furthermore, other researchers can also build on the findings of this research study and apply these to their own research.

It is anticipated that the findings of this study will be of significance to teachers and advisors in Abu Dhabi, as they could provide teachers with the impetus to refocus and improve their teaching practices. Teachers are more likely to contribute to improving student attitudes towards science if they have a good understanding of what encourages this.

It is anticipated that the findings of this study will be significant to school administrators and other policy makers and educational organisations. Policy makers in other countries could benefit from my findings when considering the introduction of any form of educational reform in both science and other subjects. Organisations such as ADEC can use these findings as a basis to drive future decisions associated with policies in education and strategies for teaching and learning, such as cooperative learning and associated intervention programmes.

6.6 Final Remarks

This study is significant to the field of learning environments and to science education, because it is the first study of its kind to examine the impact of cooperative learning on student perceptions of the learning environment and their outcomes in science classes in Abu Dhabi, UAE. Additionally, it is the first study to provide evidence for the reliability of the newly-developed and translated ACL instrument, making it suitable for use in other studies.

The findings of this study suggest that the implementation of cooperative learning strategies in science lessons in Abu Dhabi has improved student attitudes. Although the focus of this study was on science learning, the findings could help educators improve their learning environments and student attitudes in other subject areas. These findings have implications for researchers, policy makers, organisations, school administration and teachers wishing to improve the learning environment and student attitude outcomes. It is anticipated that the research presented in this thesis has produced valuable information that can help to transform future science classrooms for the benefit of all stakeholders. Ultimately, my findings can be used in the future to help to transform future science classrooms in ways that motivate and engage learners who aspire to be the next generation of scientists.

REFERENCES

- Adams, W.K., Perkins, K.K., Podolefsky, N.S., Dubson, M., Finkelstein, N.D., & Wieman, C.E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey. *Physics Education Research*, 2. Retrieved on April 17, 2015, from <http://dx.doi.org/10.1103/PhysRevSTPER.2.010101>.
- ADEC. (2013). *Abu Dhabi Education Council*. Retrieved on February 17, 2013, from <http://www.adec.ac.ae/english/pages/Schools.aspx?LinkId=cxmKDhwpHbXtBqP1OszvQw>.
- Acar, B., & Tarhan, L. (2008). Effects of cooperative learning on students' understanding of metallic bonding. *Research in Science Education*, 38(4), 401-420.
- Afari, E., Aldridge, J.M., Fraser, B.J., & Khine, M.S. (2013). Students' perceptions of the learning environment and attitudes in game-based mathematics classrooms. *Learning Environments Research*, 16, 131-150.
- Ajzen, I. (2001). Nature and operation of attitudes. *Annual Review of Psychology*, 52, 27-58.
- Akinbobola, A.O. (2009). Enhancing students' attitude towards Nigerian senior secondary school physics through the use of cooperative, competitive and individualistic learning strategies. *Australian Journal of Teacher Education*, 34(1), 1-9.
- Akkus, R., Gunel, M., & Hand, B. (2007). Comparing an inquiry-based approach known as the science writing heuristic to traditional science teaching practices: Are there differences? *International Journal of Science Education*, 29(14), 1745-1765.
- Allen, D., & Fraser, B.J. (2007). Parent and student perceptions of classroom learning environments and its association with student outcomes. *Learning Environments Research*, 10, 67-82.
- Al-Fahim, M. (1995). *From rags to riches: A story of Abu Dhabi*. London: Centre of Arab Studies.

- Al-Yaseen, W.S. (2011). Expectations of a group of primary school teachers trained on cooperative learning on the possibility of successful implementations. *Education, 132*, 273-284.
- Aldridge, J.M., & Fraser, B.J. (2000). A cross-cultural study of classroom learning environments in Australia and Taiwan. *Learning Environments Research, 3*, 101-134.
- Aldridge, J.M., & Fraser, B.J. (2008). *Outcomes-focused learning environments: Determinants and effects*. (Advances in Learning Environments Research series). Rotterdam, The Netherlands: Sense Publishers.
- Aldridge, J.M., Fraser, B.J., & Huang, I.T.-C. (1999). Investigating classroom environments in Taiwan and Australia with multiple research methods. *Journal of Educational Research, 93*, 48-62.
- Aldridge, J.M., Fraser, B.J., & Ntuli, S. (2009). Utilising learning environment assessments to improve teaching practices among in-service teachers undertaking a distance education programme. *South African Journal of Education, 29*, 147-170.
- Aldridge, J.M., Fraser, B.J., & Sebela, M.P. (2004). Using teacher action research to promote constructivist learning environments in South Africa. *South African Journal of Education, 24*, 245-253.
- Aldridge, J.M., Fraser, B.J., Taylor, P.C., & Chen, C.C. (2000). Constructivist learning environments in a cross-national study in Taiwan and Australia. *International Journal of Science Education, 22*, 37-55.
- Aldridge, J.M., Laugksch, R.C., & Fraser, B.J. (2006). School-level environment and outcomes-based education in South Africa. *Learning Environments Research, 9*, 123-147.
- Aldridge, J.M., Laugksch, R.C., Seopa, M.A., & Fraser, B.J. (2006). Development and validation of an instrument to monitor the implementation of outcomes-based learning environments in science classrooms in South Africa. *International Journal of Science Education, 28*, 45-70.
- Allen, D., & Fraser, B.J. (2007). Parent and student perceptions of classroom learning environment and its association with student outcomes. *Learning Environments Research, 10*, 67-82.
- Altinok, H. & Acikgoz, K.U. (2006). Effects of cooperative and individual concept mapping on attitudes toward science. *I.H.U Journal of Education, 30*, 21-29.

- Al Zubaidi, E., Aldridge, J.M., & Khine, M.S. (2016). Learning English as a second language at the university level in Jordan: Motivation, self-regulation and learning environment perceptions. *Learning Environments Research*. Retrieved from online first on April 15th 2015 from <http://link.springer.com/article/10.1007/s10984-014-9169-7>.
- Anderson, G. (1998). *Fundamentals of educational research* (2nd ed.). London: Routledge.
- Anderson, G.J., & Walberg, H.J. (1974). *Learning Environments*. In H.J. Walberg (Ed.), *Evaluating educational performance: A sourcebook of methods, instruments, and exemplars* (pp. 81-98). Berkeley, CA: McCutchan.
- Anderson, J.A., & Adams, M. (1992). Acknowledging the learning styles of diverse student populations: Implications for instructional design. *New Directions for Teaching and Learning*, 49, 19-33.
- Annetta, L., Mangrum, J., Holmes, S., Collazo, K., & Cheng, M-T. (2009). Bridging reality to virtual reality: Investigating gender effect and student engagement on learning through video game play in an elementary school classroom. *International Journal of Science Education*, 31(8), 1091-1113.
- Arslan, O., Bora, N.D., & Samanci, N.K. (2006). The effect of cooperative learning strategies on 10th grade pupils' achievement on nervous system. *Egitim Arastirmalari*, 6(23), 1-9.
- Ashgar, M., & Fraser, B.J. (1995). Classroom environment and attitudes to science in Brunei Darussalam. *Journal of Science and Mathematics in Southeast Asia*, XVII, 41-47.
- Ayyildiz, Y., & Tarhan, L. (2013). Case study applications in chemistry lesson: Gases, liquids, and solids. *Chemistry Education Research and Practice*, 14, 408-420.
- Bagozzi, R.P., & Burnkrant, R.E. (1979). Attitude organisation and the attitude-behaviour relationship. *Journal of Personality and Social Psychology*, 37, 913-929.
- Baker, D.R. (1985). Predictive value of attitude, cognitive ability, and personality to science achievement in the middle school. *Journal of Research in Science Teaching*, 22(2), 103-113.

- Balfakih, N.M.A (2003). The effectiveness of student team-achievement division (STAD) for teaching high school chemistry in the United Arab Emirates. *International Journal of Science Education*, 25(5), 605-624.
- Barak, M., Ashkar, T., & Dori, Y.J. (2011). Learning science via animated movies: Its effects on students' thinking and motivation. *Computers and Education*, 56, 839-846.
- Barbera, J., Adams, W.K., Wieman, C.E., & Perkins, K.K. (2008). Modifying and validating the Colorado Learning Attitudes about Science survey for use in chemistry. *Journal of Chemical Education*, 85(10), 1435-1439.
- Barmby, P., Kind, P., & Jones, K. (2008). Examining changing attitudes in secondary school science. *International Journal of Science education*, 30(8), 1075-1093.
- Bartle, E.K., Dook, J., & Mocerino, M. (2011). Attitudes of tertiary students towards a group project in a science unit. *Chemistry Education Research and Practice*, 12, 303-311.
- Belanger, S., & Peters, S. (2008). Investigating adolescents' science stereotypes and their relationship to attitude toward science and career aspirations. Retrieved on June 12, 2015, from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.490.8449&rep=rep1&type=pdf>.
- Bell, R.L., Matkins, J.J., & Gansneder, B.M. (2011). Impacts of contextual and explicit instruction on preservice elementary teachers' understandings of the nature of science. *Journal of Research in Science Teaching*, 48(4), 414-436.
- Berger, P.L., & Luckmann, T. (1967). *The social construction of reality: A treatise in the sociology of knowledge*. New York, NY: Anchor Press.
- Bieri Buschor, C., Berweger, S., Keck Frei, A., & Kappler, C. (2014). Majoring in STEM—What accounts for women's career decision making? A mixed-methods study. *Journal of Educational Research*, 107(3), 167-176.
- Bilgin, I. (2006). The effects of hands-on activities incorporating a cooperative learning approach in eighth grade students' science process skills and attitudes towards science. *Journal of Baltic Science Education*, 1(9), 27-37.
- Bilgin, I., & Geban, O. (2004). Investigating the effects of cooperative learning strategy and gender on pre-service elementary teacher students' attitude toward science achievement of science teaching class. *I.H.U. Journal of Education*, 26, 9-18.

- Bilgin, I., & Karaduman, A. (2005). Investigating the effects of cooperative learning on 8th grade students' attitudes towards science. *Ilkogretim-online*, 4(2), 32-46.
- Bloor, M. (2010). The researcher's obligation to bring about good. *Qualitative Social Work*, 9(1), 17-20.
- Bogar, Y., Kalender, S., & Sarikaya, M. (2012). The effects of constructive learning method on students' academic achievement, retention of knowledge, gender and attitudes towards science course in "matter of structure and characteristics" unit. *Procedia-Social and Behavioural Sciences*, 46, 1766-1770.
- Box, J.A., & Little, D.C. (2003). Cooperative small-group instruction combined with advanced organisers and their relationship to self-concept and social studies achievement of elementary school students. *Journal of Instructional Psychology*, 30(4), 285-287.
- Brown, T.A. (2006). *Confirmatory factor analysis for applied research*. New York: Guilford Press.
- Burden, R.L., & Fraser, B.J. (1993). Use of classroom environment assessments in school psychology: A British perspective. *Psychology in the Schools*, 30(3), 232-240.
- Cabrera, A.F., Nora, A., Crissman, J.L., Terenzini, P.T., Bernal, E.M., & Pascarella, E.T. (2002). Collaborative learning: Its impact on college students' development and diversity. *Journal of College Student Development*, 43(1), 20-34.
- Cakiroglu, J. (1999). Gender difference in the science classroom. *Hacettepe Universitesi Egitim Falkultesi Dergisi*, 16-17, 123-133.
- Campisi, J., & Finn, K.E. (2011). Does active learning improve students' knowledge of and attitudes toward research methods? *Journal of College Science Teaching*, 40(4), 38-45.
- Cannon, R.K., & Simpson, R.D. (1985). Relationships among attitude, motivation, and achievement of ability grouped, seventh-grade, life-science students. *Science Education*, 69, 121-138.
- Castano, C. (2008). Socio-scientific discussions as a way to improve the comprehension of science and the understanding of the interrelation between species and the environment. *Research in Science Education*, 38, 565-587.

- Chang, H.P. & Mao, S.L. (1999). Comparison of Taiwan science students' outcomes with inquiry group versus traditional instruction. *Journal of Educational Research, 92*(6), 340-346.
- Chave, E.J. (1928). A new type of scale for measuring attitudes. *Religious Education, 23*, 364-369.
- Cheung, D. (2009). Developing a scale to measure students' attitudes toward chemistry lessons. *International Journal of Science Education, 31*(16), 2185-2203.
- Chionh, Y.H., & Fraser, B.J. (2009). Classroom environment, achievement, attitudes and self-esteem in geography and mathematics in Singapore. *International Research in Geographical and Environmental Education, 18*, 29-44.
- Cohen, E. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research, 64*, 1-35.
- Cohen, E.G. (2004). Pockets of excellence: Implications for organizational change. In E. Cohen, C. Brody, & M. Sapon-Shevin (Eds.), *Teaching cooperative learning: The challenge for teacher education* (pp. 195-202). Albany, NY: SUNY Press.
- Cohen, J. (1992). Quantitative methods in psychology: A power primer. *Psychological Bulletin, 112*, 155-159.
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education*. London: RoutledgeFalmer.
- Crano, W.D., & Prislin, R. (2006). Attitudes and persuasion. *Annual Review of Psychology, 57*, 345-374.
- Cresswell, J.W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage.
- Creswell, J.W., & Miller, D.L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice, 39*(3), 124-130.
- Creswell, J.W., & Plano Clark, V.L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.
- Dainton, F.S. (1968). *Enquiry into the flow of candidates in science and technology into higher education*. London: Council for Scientific Policy.
- Day, S.P., & Bryce, T.G.K. (2013). The benefits of cooperative learning to socio-scientific discussion in secondary school science. *International Journal of Science Education, 35*, 1533-1560.

- De Vaus, D.A. (2002). *Surveys in social research*. Sydney, NSW: Allen & Unwin.
- Dean, D., & Fleckenstein, A. (2007). Keys to success for women in science. In R. Burke & M. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics: Upping the numbers* (pp. 28-44). Northampton, MA: Edward Elgar Publishing.
- den Brok, P., Fisher, D., Rickards, T., & Bull, E. (2006). Californian science students' perceptions of their classroom learning environments. *Educational Research and Evaluation, 12*, 3-25.
- Demir, K. (2008). Transformational leadership and collective efficacy: The moderating roles of collaborative culture and teachers' self-efficacy. *Egitim Arastirmalari—Eurasian Journal of Educational Research, 33*, 93-112.
- Demirici, C. (2010). Cooperative learning approach to teaching science. *Egitim Arastirmalari—Eurasian Journal of Educational Research, 40*, 36-52.
- Denrell, J. (2005). Why most people disapprove of me: Experience sampling in impression formation. *Psychological Review, 112*(4), 951-978.
- Denzin, N.K., & Lincoln, Y.S. (2000). Introduction: The discipline and practice of qualitative research. In N.K. Denzin and Y.S. Lincoln (Eds.), *Handbook of Qualitative Research* (2nd ed., pp. 1-29). Thousand Oaks, CA: Sage.
- Desforges, C., & Cockburn, A.D. (1987). *Understanding the mathematics teacher: A study of first school practice*. Lewes: Falmer Press.
- Desy, E., Peterson, S., & Brockman, V. (2011). Gender differences in science-related attitudes and interests among middle school and high school students. *Science Educator, 20*(2), 23-30.
- Dhindsa, H.S., & Chung, G. (2003). Attitudes and achievement of Bruneian science students. *International Journal of Science Education, 25*, 907-922.
- Dieker, L., Grillo, K., & Ramlakhan, N. (2012). The use of virtual and simulated teaching and learning environments: Inviting gifted students into science, technology, engineering and mathematics careers (STEM) through summer partnerships. *Gifted Education International, 28*(1), 96-106.
- Doherty, J., & Dawe, J. (1985). The relationship between development maturity and attitude to school science: An exploratory study. *Educational Studies, 11*(2), 93-107.
- Dorman, J.P. (2001). Associations between classroom environment and academic efficacy. *Learning Environments Research, 4*(3), 243-257.

- Dorman, J.P. (2003). Cross-national validation of the What Is Happening In this Class? (WIHIC) questionnaire using confirmatory factor analysis. *Learning Environments Research, 6*, 231-245.
- Dorman, J.P. (2008). Use of multitrait-multimethod modelling to validate actual and preferred forms of the What Is Happening In this Class? (WIHIC) questionnaire. *Learning Environments Research, 11*, 179-197.
- Dorman, J.P., & Adams, J. (2004). Associations between students' perceptions of classroom environment and academic efficacy in Australian and British secondary schools. *Westminster Studies in Education, 27*(1), 69-85.
- Dorman, J.P., & Fraser, B.J. (2009). Psychosocial environment and affective outcomes in technology-rich classrooms: Testing a causal model. *Social Psychology of Education, 12*, 77-99.
- Doyle, W. (1979). Classroom tasks and students' abilities. In P.L. Peterson & H.L. Walberg (Eds.), *Research on teaching: Concepts, findings, and implications* (pp. 183-209). Berkeley, CA: McCutchan.
- Doymus, K., Simsek, U., & Bayrakceken, S. (2004). The effect of cooperative learning on attitude and academic achievement in science lessons. *Journal of Turkish Science Education, 1*(2), 103-115.
- Duran, M., Hoft, M., Lawson, D.B., Medjahed, B., Orady, E.A. (2014). Urban high school students' IT/STEM learning: Findings from a collaborative inquiry- and design-based afterschool program. *Journal of Science and Tecnology, 23*(1), 116-137.
- Ebenezer, J.V., & Zoller, U. (1993). Grade 10 students' perceptions of and attitudes toward science teaching and school science. *Journal of Research in Science Teaching, 30*(2), 175-186.
- Ely, M. & New York University, NY. School of Education, Health, Nursing and Arts Professions. (1984). *An evaluation of the PAL consortium computer center summer computer camp equity project. Technical report number 2.* Washington DC: ERIC Clearinghouse.
- Ercikan, K. (1998). Translation effects in international assessments. *International Journal of Educational Research, 29*, 543-553.
- Erdogan, I., & Campbell, T. (2008). Teacher questioning and interaction patterns in classrooms facilitated with differing levels of constructivist teaching practices. *International Journal of Science Education, 30*, 1891-1914.

- Fang, N. (2013). Increasing high school students' interest in STEM education through collaborative brainstorming with yo-yos. *Journal of STEM Education: Innovations and Research*, 14(4), 8-14.
- Ferguson, J., & Dorman, J. (2001). Psychosocial classroom environment and academic efficacy in Canadian high school mathematics classes. *Alberta Journal of Educational Research*, 47(3), 276-279.
- Ferguson-Patrick, K. (2011). Professional development of early career teachers: A pedagogical focus on cooperative learning. *Issues in Educational Research*, 21(2), 109-129.
- Field, A. (2009). *Discovering statistics using SPSS*. London: Sage.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Fisher, D.L., & Fraser, B.J. (1981). Validity and use of My Class Inventory. *Science Education*, 65, 145-156.
- Fisher, D.L., & Fraser, B.J. (1983). A comparison of actual and preferred classroom environment as perceived by science teachers and students. *Journal of Research in Science Teaching*, 20, 55-61.
- Fisher, D.L., Henderson, D., & Fraser, B.J. (1995). Interpersonal behaviour in senior high school biology classes. *Research in Science Education*, 25, 125-133.
- Fisher, D., Henderson, D., & Fraser, B. (1997). Laboratory environments & student outcomes in senior high school biology. *American Biology Teacher*, 59, 214-219.
- Foster, G.W. (1985). Creativity in a cooperative group setting. *Journal of Research in Science Teaching*, 22(1), 89-98.
- Francis, L.J. & Greer, J.E. (1999). Measuring attitude toward science among secondary school students: The affective domain. *Research in Science & Technological Education*, 17(2), 219-226.
- Fraser, B.J. (1981). *Test of Science-Related Attitudes handbook (TOSRA)*. Melbourne, Australia: Australian Council for Educational Research.
- Fraser, B.J. (Ed.). (1986). *The study of learning environments*. Salem, OR: Assessment Research.
- Fraser, B.J. (1994). Research on classroom and school climate. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 493-541). New York: Macmillan.

- Fraser, B.J. (1998a). Classroom environment instruments: Development, validity and applications. *Learning Environments Research*, 1, 7-33.
- Fraser, B.J. (1998b). Science learning environments: Assessment, effects and determinants. In B. Fraser & K. Tobin (Eds.), *International handbook of science education* (pp. 527-564). Dordrecht, The Netherlands: Kluwer.
- Fraser, B.J. (1999). 'Grain sizes' in learning environment research: Combining qualitative and quantitative methods. In H.C. Waxman & H.J. Walberg (Eds.), *New directions for teaching practice and research* (pp. 285-296). Berkeley, CA: McCutchan.
- Fraser, B.J. (2001). Twenty thousand hours: Editor's Introduction. *Learning Environments Research Journal*, 4, 1-5.
- Fraser, B.J. (2002). *Learning environments research: Yesterday, today and tomorrow*. In S.C. Goh & M.S. Khine (Eds.), *Studies in educational learning environments: An international perspective* (pp. 1-25). Singapore: World Scientific Publishing.
- Fraser, B.J. (2012). Classroom learning environments: Retrospect, context and prospect. In B.J. Fraser, K.G. Tobin, & C.J. McRobbie (Eds.), *Second international handbook of science education* (pp. 1191-1239). New York: Springer.
- Fraser, B.J., & Butts, W.L. (1982). Relationship between perceived levels of classroom individualization and science-related attitudes. *Journal of Research in Science Teaching*, 19, 143-154.
- Fraser, B.J., & Lee, S.S.U. (2009). Science laboratory classroom environments in Korean high schools. *Learning Environments Research*, 12, 67-84.
- Fraser, B.J., & McRobbie, C.J. (1995). Science laboratory classroom environments at schools and universities: A cross-national study. *Educational Research and Evaluation*, 1, 289-317.
- Fraser, B.J., & O'Brien, P. (1985). Student and teacher perceptions of the environment of elementary school classrooms. *Elementary School Journal*, 85, 567-580.
- Fraser, B.J., & Raaflaub, C. (2013). Subject and sex differences in the learning environment—Perceptions and attitudes of Canadian mathematics and science students using laptop computers. *Curriculum and Teaching*, 28(1), 57-78.

- Fraser, B. J., & Tobin, K. (1991). Combining qualitative and quantitative methods in classroom environment research. In B.J. Fraser & H.J. Walberg (Eds.), *Educational environments: evaluation, antecedents and consequences* (pp. 271-292). London: Pergamon.
- Fraser, B.J., & Treagust, D.F. (1986). Validity and use of an instrument for assessing classroom psychosocial environment in higher education. *Higher Education*, *15*, 37-57.
- Fraser, B.J., & Walberg, H.J. (Eds.). (1991). *Educational environments: Evaluation, antecedents and consequences*. Oxford, England: Pergamon Press.
- Fraser, B.J., Aldridge, J.M., & Adolphe, F.S.G. (2010). A cross-national study of secondary science classroom environments in Australia and Indonesia. *Research in Science Education*, *40*, 551-571.
- Fraser, B.J., Aldridge, J.M., & Soerjaningsih, W. (2010). Instructor-student interpersonal interaction and student outcomes at the university level in Indonesia. *The Open Education Journal*, *3*, 32-44.
- Fraser, B.J., Anderson, G.J., & Walberg, .J. (1982). *Assessment of learning environments: Manual for Learning Environment Inventory (LEI) and my Class Inventory (MCI)* (third version). Perth, Australia: Western Australian Institute of Technology.
- Fraser, B.J., Fisher, D.L., & McRobbie, C.J. (1996). *Development, validation and use of personal and class forms of a new classroom instrument*. Paper presented at the annual meeting of the American Educational Research Association, New York, NY.
- Fraser, B.J., Giddings, G.J., & McRobbie, C.J. (1992). Assessment of the psychosocial environment of university science laboratory classrooms: A cross-national study. *Higher Education*, *24*(4), 431-451.
- Fraser, B.J., Giddings, G.J., & McRobbie, C.J. (1995). Evolution and validation of a personal form of an instrument for assessing science laboratory classroom environments. *Journal of Research in Science Teaching*, *32*, 399-422.
- Fraser, B.J., Pearse, R., & Azmi, R. (1982). A study of Indonesian students' perceptions of classroom psychosocial environment. *International Review of Education*, *28*, 337-355.

- Fraser, B.J., Williamson, J.C., & Tobin, K. (1987). Use of classroom and school climate scales in evaluating alternative high schools. *Teaching and Teacher Education, 3*, 219-231.
- Freeman, K.E., Alston, S.T., & Winborne, D.G. (2008). Do learning communities enhance the quality of students' learning motivation in STEM? *Journal of Negro Education, 77*(3), 227-240.
- Gardner, P.L. (1995). The dimensionality of attitude scales: A widely misunderstood idea. *International Journal of Science Education, 18*(8), 913-919.
- Gardner, P.L. (1996). Measuring attitudes to science. *Research in Science education, 25*, 283-289.
- George, P.G. (2005). Using cooperative learning in the college classroom. *The NEA Higher Education Journal, 58*, 33-38.
- George, R. (2006). A cross-domain analysis of change in students' attitudes towards science and attitudes about the utility of science. *International Journal of Science Education, 28*(6), 571-589.
- Germann, P.J. (1988). Development of the attitude toward science in school assessment and its use to investigate the relationship between science achievement and attitude toward science in school. *Journal of Research in Science Teaching, 25*, 689-703.
- Gernigon, C., d'Arripe-Longueville, F., Debove, V., & Puvis, A. (2003). Situational indexes of achievement motivation, help-seeking, and performance: Influences of the learning context and gender differences. *Research Quarterly for Exercise and Sport, 74*(4), 473-479.
- Getzels, J.W., & Thelen, H.A. (1960). The classroom group as a unique social system. In N.B. Henry (Ed.), *The dynamics of instructional groups: Socio-psychological aspects of teaching and learning* (Fifty-Ninth Yearbook of National Society for Study of Education, Part 2, pp. 53-82). Chicago: University of Chicago Press.
- Giallousi, M., Gialamas, V., Spyrellis, N., & Pavlaton, E. (2010). Development, validation, and use of a Greek-language questionnaire for assessing learning environments in grade 10 chemistry classes. *International Journal of Science and Mathematics Education, 8*, 761-782.
- Gilbert, M.C., Musu-Gillette, L.E., Woolley, M.E., Karabenick, S.A., Strutchens, M.E., & Martin, G. (2014). Student perceptions of the classroom

- environment: Relations to motivation and achievement in mathematics. *Learning Environments Research*, 17(2), 287-304.
- Gillies, R.M. (2002). The residual effects of cooperative learning experiences: A two-year follow-up. *The Journal of Educational Research*, 96(1), 15-21.
- Gillies, R.M. (2003a). The behaviours, interactions, and perceptions of junior high school students during small-group learning. *Journal of Educational Psychology*, 95(1), 137-147.
- Gillies, R.M. (2003b). Structuring cooperative group work in classrooms. *International Journal of Educational Research*, 39 (1-2), 35-49.
- Gillies, R.M. (2008). The effects of cooperative learning on junior high school students' behaviours, discourse and learning during a science-based learning activity. *School Psychology International*, 29(3), 328-347.
- Gillies, R.M., & Boyle, M. (2010). Teachers' reflections on cooperative learning: Issues of implementation. *Teaching and Teacher Education*, 26, 933-940.
- Gogolin, L., & Swartz, F. (1992). A quantitative and qualitative inquiry into the attitudes toward science of nonscience college students. *Journal of Research in Science Teaching*, 29(5), 487-504.
- Goh, S.C., & Fraser, B.J. (1996). Validation of an elementary school version of the Questionnaire on Teacher Interaction. *Psychological Reports*, 79, 512-522.
- Goh, S.C., & Khine, M.S. (Eds.). (2002). *Studies in educational learning environments: An international perspective*. Singapore: World Scientific.
- Goh, S.C., Young, D.J., & Fraser, B.J. (1995). Psychosocial climate and student outcomes in elementary mathematics classrooms: A multilevel analysis. *Journal of Experimental Education*, 64, 29-40.
- Guba, N.K., & Lincoln, Y.S. (1994). *Handbook of qualitative research*. Sage Publications, Inc. Thousand Oaks, California.
- Gundara, J., & Namrata, S. (2008, January). *Synergies and critical issues for cooperative learning and intercultural education*. Paper presented at the Annual Conference of the International Association for Intercultural Education, Turin, Italy.
- Gupta, A., & Fisher, D. (2012). Technology-supported learning environments in science classrooms in India. *Learning Environments Research*, 15(2), 195-216.

- Hadden, R.A., & Johnstone, A.H. (1983). Secondary school pupils' attitudes to science: The year of decision. *European Journal of Science Education*, 5(4), 429-438.
- Haladyna, T.M., & Shaughnessy, J.M. (1982). *A manual for the inventory of affective aspects of schooling*. Monmouth, OR: Teaching Research.
- Hanze, M., & Berger, R. (2007). Cooperative learning, motivational effects, and student characteristics: An experimental study comparing cooperative learning and direct instruction in 12th grade physics classes. *Learning and Instruction*, 17, 29-41.
- Harvey, T.J., & Edwards, P. (1980). Children's expectations and realisations of science. *British Journal of Educational Psychology*, 50(1), 74-76.
- Helding, K.A., & Fraser, B.J. (2013). Effectiveness of National Board Certified (NBC) teachers in terms of classroom environment, attitudes and achievement among secondary science students. *Learning Environments Research*, 16, 1-21.
- Henderson, D., Fisher, D., & Fraser, B.J. (2000). Interpersonal behaviour, learning environments and student outcomes in senior biology classes. *Journal of Research in Science Teaching*, 37, 26-43.
- Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering and mathematics*. Washington DC: American Association for University Women.
- Hobbs, E.D., & Erickson, G.L. (1980). Results of the 1978 British Columbia science assessment. *Canadian Journal of Education*, 5(2), 63-80.
- Hofstein, A., & Welch, W. (1984). The stability of attitudes toward science between junior and senior high school. *Research in Science and Technological Education*, 2(2), 131-138.
- Hong, Z-R. (2010). Effects of a collaborative science intervention on high achieving students' learning anxiety and attitudes toward science. *International Journal of Science Education*, 32(15), 1971-1988.
- Hong, Z-R., & Lin, H-S. (2013). Boys' and girls' involvement in science learning and their self-efficacy in Taiwan. *International Journal of Psychology*, 48(3), 272-284.

- House, J.D. (2009). Classroom instructional strategies and science career interest for adolescent students in Korea: Results from the TIMMS 2003 assessment. *Journal of Instructional Psychology, 36*(1), 13-19.
- Houtz, L.E. (1995). Instructional strategy change and the attitude and achievement of seventh- and eighth-grade science students. *Journal of Research in Science Teaching, 32*(6), 629-648.
- Humphrey, L.L. (1984). Children's self-control in relation to perceived social environment. *Journal of Personality and Social Psychology, 46*, 178-188.
- Jang, S-J. (2006). The effects of incorporating web-assisted learning with team teaching in seventh-grade science classes. *International Journal of Science Education, 28*(6), 615-632.
- Johnson, D.W., & Johnson, R.T. (1989). *Cooperation and competition: Theory and research*. Edina (MN): Interaction Book Co.
- Johnson, D.W., & Johnson, R.T. (1990). *Learning together and alone*. Edina, MN: Interaction Book Company.
- Johnson, D.W., & Johnson, R.T. (1993). *Circles of Learning: Cooperation in the classroom*. 4th ed. Edina (MN): Interaction Book Co.
- Johnson, D.W., & Johnson, R.T. (1999). Making cooperative learning work. *Theory Into Practice, 38*(2), 67-74.
- Johnson, D.W., Johnson, R. & Holubec, E.J. (2008). *Cooperation in the classroom* (8th ed). Edina, MN: Interaction Book Company.
- Johnson, D.W., Johnson, R.T. & Taylor, B. (1993). Impact of cooperative and individualistic learning on high-ability students' achievement, self-esteem, and social acceptance. *The Journal of Social Psychology, 133*(6), 839-844.
- Johnson, R.B., & Onquegbuzie, A.J. (2004). Mixed methods research: A paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.
- Joiner, K.F., Malone, J.A., & Haines, D.H. (2002). Assessment of classroom environments in reformed calculus education. *Learning Environments research, 5*, 51-76.
- Jones, M.G., Andre, T., Negishi, A., Tretter, T., Kubasko, D., Bokinsky, ... Superfine, R. (2003, April). *Hands-on science: The impact of haptic experiences on attitudes and concepts*. Paper presented at the annual meeting of the National Association of Research in Science Teaching, Philadelphia, PA.

- Kagan, S. (1994). *Cooperative learning*. San Clemente, CA: Kagan Cooperative Learning.
- Kagan, S. (1995). Group grades miss the mark. *Educational Leadership*, 52, 68-72.
- Keeves, J.P. (1992). *The IEA Study of Science III: Changes in science education and achievement: 1970 to 1984*. Oxford: Pergamon.
- Kelly, G.A. (1963). *A theory of personality: The psychology of personal constructs*. New York, NY: W.W. Norton and Company.
- Kenar, I., Balci, M., & Gokalp, M.K. (2013). The effects of tablet computer assisted instruction on students' attitude toward science and technology course. *International Journal of Educational Sciences*, 5(3), 163-171.
- Kerr, C.R., Fisher, D.L., Yaxley, B.G., & Fraser, B.J. (2006). Studies of students' perceptions in science classrooms at the post-compulsory level. In D.L. Fisher & M.S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 161-194). Singapore: World Scientific.
- Khine, M.S., & Fisher, D.L. (Eds.). (2001, August). *Classroom environment and teachers' cultural background in secondary science classes in an Asian context*. Paper presented at the annual meeting of the Australian Association for Research in Education, Perth, Australia.
- Khine, M.S., & Fisher, D.L. (Eds.). (2003). *Technology-rich learning environments: A future perspective*. Singapore: World Scientific.
- Khoo, H.S., & Fraser, B.J. (2008). Using classroom psychosocial environment in the evaluation of adult computer application courses in Singapore. *Technology, Pedagogy and Education*, 17, 67-81.
- Kim, H.B., Fisher, D.L., & Fraser, B.J. (1999). Assessment and investigation of constructivist science learning environments in Korea. *Research in Science and Technological Education*, 17, 239-249.
- Kim, H.B., Fisher, D.L., & Fraser, B.J. (2000). Classroom environment and teacher interpersonal behavior in secondary school classes in Korea. *Evaluation and Research in Education*, 14, 3-22.
- Kincal, R.Y., Ergul, R., & Timur, S. (2007). Effect of cooperative learning method to student achievement in science teaching. *I.H.U. Journal of Education*, 32, 156-163.
- Kind, P.M., Jones, K., & Barmby, P. (2007). Developing attitudes towards science measures. *International Journal of Science Education*, 29 (7), 871-893.

- Kirik, O.T., & Boz, Y. (2012). Cooperative learning instruction for conceptual change in the concepts of chemical kinetics. *Chemistry Education Research and Practice*, 13(3), 221-236.
- Klopfer, L.E. (1971). Evaluation of learning science. In B.S. Bloom, J.T. Hastings, & G.F. Madaus (Eds.), *Handbook on formative and summative evaluation of student learning* (pp. 559-642). New York: McGraw Hill.
- Klosterman, M.L., & Sadler, T.D. (2010). Multi-level assessment of scientific content knowledge gains associated with socioscientific issues-based instruction. *International Journal of Science Education*, 32(8), 1017-1043.
- Korkut-Owen, F., Owen, D., & Ballestero, V. (2009). Counselors and administrators: The collaborative alliance in three countries. *Egitim Arastirmalari—Eurasian Journal of Educational Research*, 36, 23-38.
- Kose, S., Sahin, A., Ergun, A., & Gezer, K. (2010). The effects of eighth grade students' achievement and attitude toward science. *Education*, 131(1), 169-180.
- Koul, R.B., & Fisher, D.L. (2005). Cultural background and students' perceptions of science classroom learning environment and teacher interpersonal behaviour in Jammu, India. *Learning Environments Research*, 8, 195-211.
- Koul, R.B., & Fisher, D.L. (2006). A contemporary study of learning environments in Jammu, India. In D.L. Fisher and M.S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 273-296). Singapore: World Scientific.
- Koul, R., Lerdpornkulrat, T., & Chantara, S. (2011). Relationships between career aspirations and measures of motivation toward biology and physics and the influence of gender. *Journal of Science Education and Technology*, 20, 761-770.
- Koul, R., Roy, L., & Lerdpornkulrat, T. (2012). Motivational goal orientation, perceptions of biology and physics classroom learning environments and gender. *Learning Environments Research*, 15, 217-229.
- Krueger, R.A. (1988). *Focus groups: A practical guide for applied research*. London: Sage.
- Kvale, S. (1996). *Interviews: An introduction to qualitative research interviewing*. Thousand Oaks, CA: Sage.

- Kyei-Blankson, L. (2014). Training math and science teacher-researchers in a collaborative research environment: Implications for math and science education. *International Journal of Science and Mathematics Education, 12*, 1047-1065.
- Lay, Y.F., & Khoo, C.H. (2012). Relationships between actual and preferred science learning environment at tertiary level and attitudes towards science among pre-service science teachers. *Pertanika Journal of Social Science and Humanities, 20*, 1117-1142.
- Lazarides, R., & Watt, H.M.G. (2015). Girls' and boys' perceived mathematics teacher beliefs, classroom learning environments and mathematical career intentions. *Contemporary Educational Psychology, 41*, 51-61.
- Lazarowitz, R., & Hertz-Lazarowitz, R. (1998). Cooperative learning in the science curriculum, in J. Fraser, & K. Tobin (Eds.), *International Handbook of science education* (pp. 449-469). Dordrecht, the Netherlands: Kluwer Academic Publishers.
- Lazarowitz, R., Hertz-Lazarowitz, R., & Baird, J.H. (1994). Learning science in a cooperative setting: Academic achievement and affective outcomes. *Journal of Research in Science Teaching, 31*(10), 1121-1131.
- Leary, T. (1957). *An interpersonal diagnosis of personality*. New York: Ronald-Press Company.
- Lee, S.S.U., & Fraser, B.J. (2002, April). *High school science classroom learning environments in Korea*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.
- Lee, S.S.U., Fraser, B.J., & Fisher, D.L. (2003). Teacher-student interactions in Korean high school science classrooms. *International Journal of Science and Mathematics Education, 1*, 67-85.
- Levitt, K.E. (2002). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. *Science Education, 86* (1), 1-22.
- Lewin, K. (1936). *Principles of topological psychology*. New York: McGraw.
- Lewis, M. (2000). Focus group interviews in qualitative research: A review of the literature. *Action Research E-reports, 2*. Retrieved March 25, 2015, from www.fhs.usyd.edu.au/arow/arere/002.htm.

- Liaghatdar, M.J., Soltani, A., & Abedi, A. (2011). A validity study of attitudes toward science scale among Iranian secondary school students. *International Education Studies*, 4(4), 36-46.
- Lichtenstein, M.J., Owen, S.V., Blalock, C.L., Liu, Y., Ramirez, K.A., Pruski, L.A., Marshall, C.E., & Toepperwein, M.A. (2008) Psychometric reevaluation of the scientific attitude inventory-revised (SAI-II). *Journal of Research in Science Teaching*, 45(5), 600-616.
- Lightburn, M.E., & Fraser, B.J. (2007). Classroom environment and student outcomes among students using anthropometry activities in high school science. *Research in Science and Technological Education*, 25, 153-166.
- Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 140, 1-55.
- Lin, E. (2006). Cooperative learning in the science classroom. *Science Teacher*, 73(5), 35-39.
- Lin, B.-S., & Crawley III, F.E. (1987). Classroom climate and science-related attitudes of junior high school students in Taiwan. *Journal of Research in Science Teaching*, 24, 579-591.
- Lincoln, Y.S., & Denzin, N.K. (1994). Introduction: Entering the field of qualitative research. In N. Denzin & Y. Lincoln (Eds.). *Handbook of qualitative research* (pp. 1-17). Thousand Oaks, CA: Sage.
- Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.
- Liou, P.Y., & Kuo, P.J. (2014). Validation of an instrument to measure students' motivation and self-regulation towards technology learning. *Research in Science and Technological Education*, 32(2), 79-96.
- Liu, E., Lin, Ch., & Chang, C-S. (2010). Student satisfaction and self-efficacy in a cooperative robotics course. *Social Behaviour and Personality*, 38(8), 1135-1146.
- Logan, K.A., Crump, B.J., & Rennie, L.J. (2006). Measuring the computer classroom environment: Lessons learned from using a new instrument. *Learning Environments Research*, 9, 67-93.
- Lonning, R.A. (1993). Effect of cooperative learning strategies on student verbal interactions and achievement during conceptual change instruction in 10th grade general science. *Journal of Research in Science Teaching*, 30(9), 1087-1101.

- Looi, C-K., Chen, W-I, & Ng, F-K. (2010). Collaborative activities enabled by GroupScribbles (GS): An exploratory study of learning effectiveness. *Computers and Education, 54*(1), 14-26.
- Lou, Y., Abrami, P.C., Spence, J.C., Poulsen, C., Chambers, B., & d'Appollonia, S. (1996). Within-class grouping: A meta-analysis. *Review of Educational Research, 66*, 423-458.
- Luft, J.A. (2009). Beginning secondary science teachers in different induction programmes: The first year of teaching. *International Journal of Science Education, 31*, 2355-2384.
- Lumpe, A.T., & Staver, J.R. (1995). Peer collaboration and concept development-learning about photosynthesis. *Journal of Research in Science Teaching, 32*(1), 71-98.
- Lundeberg, M.A., & Moch, S.D. (1995). Influence of social interaction on cognition: Connected learning in science. *The Journal of Higher Education, 66*(3), 312-335.
- MacLeod, C., & Fraser, B.J. (2010). Development, validation and application of a modified Arabic translation of the What Is Happening In this Class? (WIHIC) questionnaire. *Learning Environments Research, 13*, 105-125.
- Majeed, A., Fraser, B.J., & Aldridge, J.M. (2002). Learning environment and its association with student satisfaction among mathematics students in Brunei Darussalam. *Learning Environments Research, 5*, 203-226.
- Markic, S., & Eilks, I. (2012). A comparison of student teachers' beliefs from four different science teaching domains using a mixed methods design. *International Journal of Science Education, 34*, 589-608.
- Marks, M., & O'Connor, A. (2013). Understanding students' attitudes about group work: What does this suggest for instructors of business? *Journal of Education for Business, 88*(3), 147-158.
- Margianti, E.S., Fraser, B.J., & Aldridge, J.M. (2001). *Learning environment, mathematical ability and student's outcomes in university computing courses in Indonesia*. Paper presented at the Annual Meeting of the American Educational Research Association, Seattle.
- Marshall, C., & Rossman, G.B. (1999). *Designing qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.

- Martin-Dunlop, C., & Fraser, B.J. (2008). Learning environments and attitudes associated with an innovative course designed for prospective elementary teachers. *International Journal of Science and Mathematics Education*, 6, 163-190.
- McCown, R.R, Driscoll, M., Roop, P., Saklofske, D.H., Kelly, I.W., Schwean, V.L., & Gajadharsingh, J. (1996). *Educational psychology: A learning-centered approach to classroom practice*. Scarborough, Ontario: Allyn & Bacon Canada.
- McGuire, W.J. (1985). Attitude and attitude change. In G. Lindzey & E. Aronson (Eds.), *Handbook of social psychology* (pp. 233-346). New York: Random House.
- Meij, H., Meij, J., & Harmsen, R. (2015). Animated pedagogical agents' effects on enhancing student motivation and learning in a science inquiry learning environment. *Educational Technology Research and Development*, 63(3), 381-403.
- Meluso, A., Zheng, M., Spires, H.A. & Lester, J. (2012). Enhancing 5th graders' science content knowledge and self-efficacy through game-based learning. *Computers & Education*, 59, 497-504.
- Miles, M.B., & Huberman, A.M. (1984). *Qualitative data analysis*. Beverly Hills: Sage.
- Millis B.J. (2002). *Enhancing learning—and more!—through cooperative learning*. Manhatta, KS: Idea Center.
- Mink, D., & Fraser, B. (2005). Evaluation of a K-5 mathematics program which integrates children's literature: Classroom environment and attitudes. *International Journal of Science and Mathematics Education*, 3(1), 59-85.
- Moebius-Clune, B.N., Elsevier, I.H., Crawford, B.A., Trautmann, N.M., Schindelbeck, R.R., & Van Es, H.M. (2011). Moving authentic soil research into high school classrooms: Student engagement and learning. *Journal of Natural Resources and Life Sciences Education*, 40, 102-113.
- Moffat, N., Pibum, M., Sidlik, L.P., Baker, D.R., & Trammel, R. (1992, March). *Girls and science careers: Positive attitudes are not enough*. Paper presented at the National Association for Research in Science Teaching, Boston, MA.

- Moore, R.W., & Sutman, F.X. (1970). The development, field test, and validation of an inventory of scientific attitudes. *Journal of Research in Science Teaching*, 7, 85-94.
- Moos, R.H. (1974). *The Social Climate Scales: An overview*. Palo Alto, CA: Consulting Psychologists Press.
- Moos, R.H. (1979). *Evaluating educational environments: Procedures, measures, findings and policy implications*. San Francisco, CA: Jossey-Bass.
- Moos, R.H., & Trickett, E.J. (1974). *Classroom environment scale manual*. Palo Alto, CA: Consulting Psychologists Press.
- Moos, R.H., & Trickett, E.J. (1987). *Classroom Environment Scale manual* (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.
- Morse, J.M. (2003). A review committee's guide to evaluating qualitative proposal. *Qualitative Health Research*, 13(6), 833-851.
- Moustafa, A., Ben-Zvi-Assaraf, O., & Eshach, H. (2013). Do junior high school students perceive their learning environments as constructivist? *Journal of Science Education and Technology*, 22, 418-431.
- Mullis, I.V.S., Martin, M.O., Ruddock, G.J., O'Sullivan, C.Y., Arora, A., & Eberber, E. (2005). TIMMS 2007 Assessment Frameworks. Chestnut Hill, MA: Boston College, TIMMS & PIRLS International Study Centre. Accessed on May 5, 2015, from <http://timss.bc.edu/isc/publications.html>.
- Munby, H. (1983). Thirty studies involving the "Scientific Attitude Inventory": What confidence can we have in this instrument? *Journal of Research in Science Teaching*, 20(2), 141-162.
- Munby, H. (1997). Issues of validity in science attitude measurement. *Journal of Research in Science Teaching*, 34, 337-341.
- Murcia, K. (2008). Re-thinking the development of scientific literacy through a rope metaphor. *Research in Science education*, 39, 215-229.
- Murphy, C., & Beggs, J. (2001, September). Pupils' attitudes, perceptions and understanding of primary science: Comparisons between Northern Irish and English schools. Paper presented at the Annual Conference of the British Educational Research Association, University of Leeds, England.
- Murray, H.A. (1938). *Explorations in personality*. New York: Oxford University Press.

- Naugah, J., & Watts, M. (2013). Girls and science education in Mauritius: A study of science class practices and their effects on girls. *Research in Science and Technological Education* 31(3), 252-268.
- Nausheen, M. Alvi, E., Munir, S., & Anwar, R. (2013). Attitudes of postgraduate students towards cooperative learning. *Journal of Educational Research*, 16(2), 107-115.
- Nix, R.K., Fraser, B.J., & Ledbetter, C.E. (2005). Evaluating an integrated science learning environment using the Constructivist Learning Environment Survey. *Learning Environments Research*, 8, 109-133.
- Nunnally, J.C., & Bernstein, I.H. (1994). *Psychometric theory*. New York, NY: McGraw-Hill, Inc.
- Okan, Z. (2008). Computing laboratory classes as language learning environments. *Learning Environments Research*, 11, 31-48.
- Ogbuehi, P.I., & Fraser, B.J. (2007). Learning environment, attitudes and conceptual development associated with innovative strategies in middle-school mathematics. *Learning Environments Research*, 10, 101-114.
- Okebukola, P.A. (1985). The relative effectiveness of cooperative and competitive interaction techniques in strengthening students' performance in science classes. *Science Education*, 69(4), 501-509.
- Opdecam, E., Everaert, P., Van Keer, H., & Buysschaert, F. (2014). Preferences for team learning and lecture-based learning among first-year undergraduate accounting students. *Research in Higher Education*, 55, 400-432.
- Opolot-Okurut, C. (2010). Classroom learning environment and motivation towards mathematics among secondary school students in Uganda. *Learning Environments research*, 13, 267-277.
- Ormerod, M.B. and Duckworth, D. (1975). *Pupils' attitudes to science*. Windsor, UK: National Foundation for Educational Research.
- Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implication. *International Journal of Science Education*, 25(9), 1049-1079.
- Parsons, E.R.C., Tran, L.U., & Gomillion, C.T. (2008). An investigation of student roles within small, racially mixed science groups: A racial perspective. *International Journal of Science Education*, 30, 1469-1489.
- Patton, M.Q. (1980). *Qualitative evaluation methods*. Thousand Oaks, CA: Sage.

- Peer, J., & Fraser, B.J. (2015). Sex, grade-level and stream differences in learning environment and attitudes to science in Singapore primary schools. *Learning Environments Research*, 18, 143-161.
- Pell, T., & Jarvis, T. (2001). Developing attitude to science scales for use with children of ages from five to eleven years. *International Journal in Science Education*, 23(8), 847-862.
- Pescarmona, I. (2011). Working on cooperative learning: Challenges in implementing a new strategy. *International Journal of Pedagogies and Learning*, 6(3), 167-174.
- Pickett, L.H., & Fraser, B.J. (2009). Evaluation of a mentoring program for beginning teachers in terms of the learning environment and student outcomes in participants' school classrooms. In A. Selkirk & M. Tichenor (Eds.), *Teacher education: Policy, practice and research* (pp. 1-15). New York: Nova Science Publishers.
- Quek, C.L., Wong, A.F.L., & Fraser, B.J. (2005). Student perceptions of chemistry laboratory learning environments, student-teacher interactions and attitudes in secondary school gifted education classes in Singapore. *Research in Science Education*, 35, 299-321.
- Rajecki, D.W. (1990). *Attitudes*. Sunderland, MA: Sinauer.
- Reid, N. (2006). Thoughts on attitude measurement. *Research in Science and Technological Education*, 24(1), 3-27.
- Reid, N., & Skryabina, E.A. (2002). Attitudes towards physics. *Research in Science and Technological Education*, 20(1), 67-81.
- Rentoul, A.J., & Fraser, B.J. (1979). Conceptualisation of enquiry-based or open classroom learning environments. *Journal of Curriculum Studies*, 11, 233-245.
- Ritchie, S.M., Tomas, L., & Tones, M. (2011). Writing stories to enhance scientific literacy. *International Journal of Science Education*, 33(5), 685-707.
- Robinson, E., & Fraser, B.J. (2013). Kindergarten students' and parents' perceptions of science classroom environments: Achievement and attitudes. *Learning Environments Research*, 16(3), 315-328.
- Ruiz, L.M., Graupera, J.L., Moreno, J.A., & Rico, I. (2010). Social preferences for learning among adolescents in secondary physical education. *Journal of Teaching in Physical Education*, 29(1), 3-20.

- Sahlberg, P. (2010). Hope of cooperative learning: International talk in Albanian secondary school classrooms. *Intercultural Education, 21*, 205-218.
- Samulewicz, D., Vidican, G., & Aswad, N.G. (2012). Barriers to pursuing careers in science, technology and engineering for women in the United Arab Emirates. *Gender, Technology and Development, 16*(2), 125-152.
- Saunders, K.J., & Fisher, D.L. (2006). An action research approach with primary pre-service teachers to improve university and primary school classroom environments. In D.L. Fisher & M.S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 247-272). Singapore: World Scientific.
- Schibeci, R.A. (1984). Attitudes to science: An update. *Studies in Science Education, 11*, 26-59.
- Schibeci, R.A., & McGaw, B. (1981). Empirical validation of the conceptual structure of a test of science related attitudes. *Educational and Psychological Measurement, 41*, 1195-1201.
- Schibeci, R.A. and Riley, J.P. (1986). Influence of students' background and perceptions on science attitudes and achievement. *Journal of Research in Science Teaching, 23*, 177-187.
- Schram, A.B. (2014). A mixed methods content analysis of the research literature in science education. *International Journal of Science Education, 36*, 2619-2638.
- Schreiner, C., & Sjøberg, S. (2007). Science education and youth's identity construction: Two incompatible projects? In D. Corrigan, J. Dillon & R. Gunstone (Eds.), *The re-emergence of values in the science curriculum* (pp. 231-247). Rotterdam: Sense Publishers.
- Schachar, H., & Fischer, S. (2004). Cooperative learning and the achievement of motivation and perceptions of students in 11th grade chemistry classes. *Learning and Instruction, 14*(1), 69-87.
- Schwandt, T.A. (2000). Three epistemological stances for qualitative inquiry: Interpretivism, hermeneutics and social constructionist. In N.K. Denzin and Y.S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 189-214). Thousand Oaks: Sage.

- Scott, R., & Fisher, D.L. (2004). Development, validation and application of a Malay translation of an elementary version of the Questionnaire on Teacher Interaction. *Research in Science Education, 34*, 173-194.
- Scott Houston, L., Fraser, B.J., & Ledbetter, C.E. (2008). An evaluation of elementary school science kits in terms of classroom environment and student attitudes. *Journal of Elementary Science Education, 20*, 29-47.
- Semsar, K., Knight, J.K., Birol, G., & Smith, M.K. (2011). The Colorado learning attitudes about science survey (CLASS) for use in biology. *CBE-Life Sciences Education, 10*, 268-278.
- Senol, H., Bal, S., Yildirim, H.I. (2007). The effect of cooperative learning on pupils' success and attitudes toward science and teaching sensory organs at 6th grade. *Kastamonu Education Journal, 15*(1), 211-220.
- Shachar, H., & Sharan, S. (1994). Talking, relating, and achieving: Effects of cooperative learning and whole-class instruction. *Cognition and Instruction, 12*, 313-353.
- Shadrek, M. (2012). Zimbabwean science students' perceptions of their classroom learning environments and attitude towards science. *Mediterranean Journal of Social Sciences, 3*(11), 415-425.
- Shanahan, M-C., & Nieswandt, M. (2011). Science student role: Evidence of social structural norms specific to school science. *Journal of Research in Science Teaching, 48*(4), 367-395.
- Sharan, Y. (2010). Cooperative learning for academic and social gains: Valued pedagogy, problematic practice. *European Journal of Education, 45*(2), 300-313.
- Shrigley, R.L. (1983). Book review. *Journal of Research in Science Teaching, 20*(1), 87-89.
- Shulman, L.S. (1997). Disciplines of inquiry in education: A new overview. In R.M. Jaegar (Ed.), *Complementary methods for research in education* (2nd ed., pp. 3-29). Washington, DC: American Educational Research Association.
- Simpson, R.D., & Oliver, J.S. (1985). Attitude toward science and achievement motivation profiles of male and female science students in grades six through ten. *Science Education, 69*(4), 511-526.

- Sink, C.A., & Spencer, L.R. (2005). My Class Inventory: Short form as an accountability tool for elementary school counsellors to measure classroom climate. *Professional School Counseling, 9*, 37-48.
- Slavin, R.E. (1995). *Cooperative learning: Theory, research, and practice* (2nd ed.). Boston: Allyn & Bacon.
- Slavin, R.E. (2010). Cooperative learning: What makes groupwork work? In H. Dumont, D. Istance, & F. Benavides (Eds.), *The Nature of Learning: Using Research to Inspire Practice* (pp. 161-178). Paris: OECD.
- Smith, M.C., Walker, D.A., & Hamidova, N. (2012). *The Attitudes toward Science scale revisited: Attitudes and beliefs about science as a multidimensional composition*. American Educational Research Association, Vancouver, British Columbia, Canada.
- Stern, G.G. (1970). *People in context: Measuring person-environment congruence in education and industry*. New York: Wiley.
- Stern, G.G., Stein, M. I., & Bloom, B.S. (1956). *Methods in personality assessment*. Glencoe, IL: Free Press.
- Stolarchuk, E., & Fisher, D. (2001). An investigation of teacher-student interpersonal behaviour in science classrooms using laptop computers. *Journal of Educational Computing Research, 24*(1), 41-55.
- Sung, H.Y., & Hwang, G.J. (2013). A collaborative game-based learning approach to improving students' learning performance in science courses. *Computers and Education, 63*, 43-51.
- Tarhan, L., & Sesen, B.A. (2010). Investigation into the effectiveness of laboratory works related to "acids and bases" on learning achievements and attitudes toward laboratory. *Procedia Social and Behavioural Sciences, 2*, 2631-2636.
- Taylor, S.P.G. (2012). *Exploration of collaborative learning environments in New Zealand secondary school science classrooms*. Unpublished doctoral thesis, Curtin University. Retrieved May 17, 2015, from <http://catalogue.curtin.edu.au>.
- Taylor, P.C., Fraser, B.J., & Fisher, D.L. (1997). Monitoring constructivist classroom learning environments. *International Journal of Educational Research, 27*, 293-302.
- Teddlie, C., & Tashakkori, A. (2006). A general typology of research designs featuring mixed methods. *Research in the Schools, 13*(1), 12-28.

- Teh, G.L., & Fraser, B.J. (1994). An evaluation of computer-assisted learning in terms of achievement, attitudes and classroom environment. *Evaluation and Research in Education*, 8, 147-161.
- Teh, G.L., & Fraser, B.J. (1995). Associations between student outcomes and geography classroom environment. *International Research in Geographical and Environmental Education*, 4(1), 3-18.
- Telli, S., Cakiroglu, J., & den Brok, P. (2006). Turkish secondary education students' perceptions of their classroom learning environment and their attitude towards biology. In D.L Fisher & M.S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 517-542). Singapore: World Scientific.
- Telli, S., den Brok, P., & Cakiroglu, J. (2010). The Importance of teacher-student interpersonal relationships for Turkish students' attitudes towards science. *Research in Science and Technological Education*, 28(3), 261-276.
- Thompson, B. (2002). What future quantitative social science research could look like: Confidence intervals for effect sizes. *Educational Researcher*, 31, 25-32.
- Tobin, K., & Fraser, B. J. (1998). Qualitative and quantitative landscapes of classroom learning environments. In B. J. Fraser & K. G. Tobin (Eds.), *The international handbook of science education* (pp. 633-640). Dordrecht: Kluwer Academic.
- Townsend, M.A.R., & Hicks, L. (1997). Classroom goal structures, social satisfaction and the perceived value of academic tasks. *British Journal of Educational Psychology*, 67, 1-12.
- Treagust, D.F. (2007). General instructional methods and strategies. In Abell, S.K. and Lederman, N.G. (Eds.), *Handbook of research on science education* (pp. 373-391). Mahwah, NJ: Erlbaum.
- Trickett, E.J., & Moos, R.H. (1973). Social environment of junior high and high school classrooms. *Journal of Educational Psychology*, 65, 93-102.
- Trochim, W.M., & Donnelly, J.P (2006). *The research methods knowledge base* (3rd ed.). Cincinnati, OH: Atomic Dog.
- Tseng, K.H., Chang, C.C., Lou, S.J., & Chen, W.P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal of Technology and Design Education*, 23(1), 87-102.

- Ucar, S., Trundle, K.C., & Krissek, L. (2011). Inquiry-based instruction with archived, online data: An intervention study with preservice teachers. *Research in Science Education, 41*(2), 261-282.
- UNESCO (2012). *A place to learn: Lessons from research on learning environments*. Accessed on July 3, 2015, from <http://www.uis.unesco.org/Education/Documents/tp9-learning-environments-2012-en.pdf>.
- Velayutham, S., & Aldridge, J.M. (2013). Influence of psychosocial classroom environment on students' motivation and self-regulation in science learning: A structural equation modeling approach. *Research in Science Education, 43*, 507-527.
- Velayutham, S., Aldridge, J., & Fraser, B. (2011). Development and validation of an instrument to measure students' motivation and self-regulation in science learning. *International Journal of Science Education, 33*, 2159-2179.
- van Aalderen-Smeets, S., & van der Molen, J.W. (2013). Measuring primary teacher's attitudes toward teaching science: Development of the Dimensions of Attitude toward Science (DAS) instrument. *The International Journal of Science Education, 35*, 577-600.
- Wachanga, S. and Mwangi, J. (2004). Effects of the cooperative class experiment teaching method on secondary school students' chemistry achievement in Kenya's Nakuru district. *International Education Journal, 5*, 26-35.
- Wahyudi, W., & Treagust, D.F. (2004). The status of science classroom learning environments in Indonesian lower secondary schools. *Learning Environments Research, 7*, 43-63.
- Walberg, H.J. (1968). *Teacher personality and classroom climate*. *Psychology in the Schools, 5*, 163-169.
- Walberg, H.J., & Anderson, G.J. (1968). Classroom climate and individual learning. *Journal of Educational Psychology, 59*, 414-419.
- Walberg, H.J., & Anderson, G.J. (1972). Properties of the achieving urban classes. *Journal of Educational Psychology, 63*, 381-385.
- Wang, J., & Staver, J.R. (2001). Examining relationships between factors of science education and student career aspiration. *The Journal of Educational Research, 94*(5), 312-319.
- Wang, M. (2012). Effects of cooperative learning on achievement motivation of female university students. *Asian Social Science, 8*, 108-114.

- Warwick, D.P., & Osherson, S. (1973). Comparative analysis in the social sciences. In D.P. Warwick and S. Osherson (Eds). *Comparative research methods: An overview* (pp. 3-41). Englewood Cliffs, NJ: Prentice-Hall.
- Webb, N., Troper, J., & Fall, R. (1995). Constructive activity and learning in collaborative small groups. *Journal of Educational Psychology, 87*, 406-423.
- Webb, N.M., Nemer, K.M., Chizhik, A.W., & Sugrue, B. (1998). Equity issues in collaborative group assessment: Group composition and performance. *American Educational Research Journal, 35*, 607-661.
- Webster, B.J., & Fisher, D.L. (2004). School-level environment and student outcomes in mathematics. *Learning Environments Research, 6*, 309-326.
- Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*(4), 387-398.
- Wheeler, L.B., Bell, R.L., & Whitworth, B.A. (2015). The science ELF: Assessing the enquiry levels framework as a heuristic for professional development. *International Journal of Science Education, 37*(1), 55-81.
- Winther, A.A., & Volk, T.L. (1994). Comparing achievement of inner-city high school students in traditional versus STS-based chemistry courses. *Journal of Chemical Education, 71*(6), 501-505.
- Withall, J. (1949). The development of a technique for the measurement of social-emotional climate in classrooms. *Journal of Experimental Education, 17*, 347-361.
- Wolf, S.J., & Fraser, B.J. (2008). Learning environment, attitudes and achievement among middle-school science students using inquiry-based laboratory activities. *Research in Science Education, 38*, 321-341.
- Wong, A.F.L., & Fraser, B.J. (1996). Environment-attitude associations in the chemistry laboratory. *Research in Science and Technological Education, 14*, 91-102.
- Wu, Y.T., & Tsai, C.C. (2007). High school students' informal reasoning on a socio-scientific issue: Qualitative and quantitative analyses. *International Journal of Science Education, 29*, 1163-1187.
- Wubbels, T., Brekelmans, M.Y, & Hooymayers, H. (1991). Interpersonal teacher behaviour in the classroom. In B.J. Fraser and H.J. Walberg (Eds.),

- Educational environments: Evaluation, antecedents and consequences* (pp. 141-160). London, UK: Pergamon Press.
- Wubbels, T., & Brekelmans, M. (2005). Two decades of research on teacher-student relationships in class. *International Journal of Educational Research*, 43, 6-24.
- Wubbels, T., & Levy, J. (Eds.). (1993). *Do you know what you look like?: Interpersonal relationships in education*. London: Falmer Press.
- Yager, R.E., Simmons, P., & Penick, J. (1989). Student perceptions of the usefulness of school science experiences. *School Science and Mathematics*, 89(4), 313-319.
- Yager, R.E., & Yager, S.O. (1985). Changes in perceptions of science for third, seventh, and eleventh grade students. *Journal of Research in Science Teaching*, 22(4), 347-358.
- Yates, S.M. (2011). Single-sex boys' school perceptions of coeducational classroom learning environments. *Learning Environments Research*, 14, 1-10.
- Yetisir, M.I., & Ceylan, E. (2015). The adaptation of students' adaptive learning engagement in science scale into Turkish. *Elementary Education Online*, 14(2), 657-670.
- Yin, R.K. (2011). *Qualitative research from start to finish*. New York, NY: The Guilford Press.
- Zacharias, Z. & Barton, A.C. (2004). Urban middle-school students' attitudes toward a defined science. *Science Education*, 88, 197-222.
- Zandvliet, D.B., & Fraser, B.J. (2004). Learning environments in information and communications technology classrooms. *Technology, Pedagogy and Education*, 13, 97-123.
- Zandvliet, D.B., & Fraser, B.J. (2005). Physical and psychosocial environments associated with networked classrooms. *Learning Environments Research*, 8, 1-17.
- ZU. (2015). *Zayed University*. Retrieved on July 22, 2015 from http://www.zu.ac.ae/main/en/_careers/living/story.aspx.
- Zwickl, B.M., Finkelstein, N., & Lewandowski, H.J. (2012, August). *Development and validation of the Colorado learning and attitudes about science survey experimental physics*. Paper presented at the Physics Education Research Conference, Philadelphia, PA.

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APPENDIX A

Arabic/English Version of the

What Is Happening In this Class (WIHIC)

Source of scales

Aldridge, Fraser and Huang (1999)

Used with permission of the authors

Name الاسم _____ School المدرسة _____ Class الصف _____ Science Teacher المعلم _____

ماذا يحدث في هذا الفصل

What Is Happening In this Class

الاتجاهات

هذا الاستبيان يحتوي على عدد من البيانات حول الممارسات التي تحصل خلال حصص العلوم. سوف يطلب منك معرفة حصول كل ممارسة بالنسبة لك. لا يوجد اجابة "صح" أو "خطأ". رأيك هو المطلوب. فكر جيداً كيف يصف كل بيان ماذا تعني حصة العلوم بالنسبة لك.

Instructions

This survey contains statements about practices which take place during **science lessons**. You will be asked how often each practice takes place. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. **Think about how well each statement describes what science lessons are like for you.**

Draw a circle around:

ضع دائرة حول:

- | | | |
|---|--|----------------------|
| 1 | If the practice takes place اذا كانت هذه الممارسة تحصل | Almost Never أبداً |
| 2 | If the practice takes place اذا كانت هذه الممارسة تحصل | Seldom نادراً |
| 3 | If the practice takes place اذا كانت هذه الممارسة تحصل | Sometimes أحياناً |
| 4 | If the practice takes place اذا كانت هذه الممارسة تحصل | Often غالباً |
| 5 | If the practice takes place اذا كانت هذه الممارسة تحصل | Almost Always دائماً |

بيان Statement	أبداً Almost Never	نادراً Seldom	أحياناً Some- times	غالباً Often	دائماً Almost Always
تماسك الطالب STUDENT COHESIVENESS					
أقيم صداقات بين الطلاب في هذا الفصل I make friendships among students in this class.	1	2	3	4	5
أعرف طلاب آخرين في هذا الفصل I know other students in this class.	1	2	3	4	5
أنا صديق لطلاب آخرين في هذا الفصل I am friendly to members of this class.	1	2	3	4	5
طلاب الفصل هم أصدقاؤني Members of the class are my friends.	1	2	3	4	5
أعمل جيداً مع طلاب الفصل الآخرين I work well with other class members.	1	2	3	4	5

بيان Statement	أبداً Almost Never	نادراً Seldom	أحياناً Some- times	غالباً Often	دائماً Almost Always
أساعد الطلاب الذين يواجهون مشاكل في الفصل I help other class members who are having trouble with their work.	1	2	3	4	5
طلاب هذا الفصل يحبونني Students in this class like me.	1	2	3	4	5
في هذا الفصل, أتلقى المساعدة من طلاب آخرين In this class, I get help from other students.	1	2	3	4	5
دعم المعلم TEACHER SUPPORT					
يهتم الأستاذ بي بصورة شخصية The teacher takes a personal interest in me.	1	2	3	4	5
يستعمل الأستاذ عدة وسائل لمساعدتي The teacher goes out of his/her way to help me.	1	2	3	4	5
الأستاذ يعطي الاعتبار لمشاعري The teacher considers my feelings.	1	2	3	4	5
الأستاذ يساعدني عندما أواجه صعوبات في واجبي The teacher helps me when I have trouble with the work.	1	2	3	4	5
الأستاذ يكلمني The teacher talks with me.	1	2	3	4	5
بيدي الأستاذ الاهتمام لمشاكلي The teacher is interested in my problems.	1	2	3	4	5
الأستاذ يتابع معي The teacher checks in with me.	1	2	3	4	5
تساعدني أسئلة الأستاذ على الفهم The teacher's questions help me to understand.	1	2	3	4	5
المشاركة INVOLVEMENT					
أناقش أفكارني في الفصل I discuss ideas in class.	1	2	3	4	5
أعطي رأيي خلال نقاشات الفصل I give my opinions during class discussions.	1	2	3	4	5
يسألني الأستاذ أسئلة The teacher asks me questions.	1	2	3	4	5
تستخدم أفكارني واقتراحاتي خلال نقاشات الفصل My ideas and suggestions are used during classroom discussions.	1	2	3	4	5

بيان Statement	أبداً Almost Never	نادراً Seldom	أحياناً Some- times	غالباً Often	دائماً Almost Always
أطرح أسئلة على الأستاذ I ask the teacher questions.	1	2	3	4	5
أشرح أفكارى للطلاب الآخرين I explain my ideas to other students.	1	2	3	4	5
يناقش الطلاب معي كيفية حل المشاكل Students discuss with me how to go about solving problems.	1	2	3	4	5
يتم سؤالي عن كيفية حلّي للمشاكل I am asked to explain how I solve problems.	1	2	3	4	5
التعاون COOPERATION					
أتعاون مع الطلاب الآخرين في حل الواجب I cooperate with other students when doing assignment work.	1	2	3	4	5
أشارك الطلاب الآخرين في مصادري عند حل الواجبات المدرسية I share my resources with other students when doing assignments.	1	2	3	4	5
عندما أعمل مع مجموعة في هذا الفصل تكون هناك روح الفريق When I work in groups in this class, there is teamwork.	1	2	3	4	5
أعمل مع الطلاب الآخرين في المشاريع في هذا الفصل I work with other students on projects in this class.	1	2	3	4	5
أتعلم من طلاب آخرين في هذا الفصل I learn from other students in this class.	1	2	3	4	5
أعمل مع طلاب آخرين في هذا الفصل I work with other students in this class.	1	2	3	4	5
أتعاون مع طلاب آخرين في نشاطات الفصل I cooperate with other students on class activities.	1	2	3	4	5
يعمل الطلاب معي لتحقيق أهداف الفصل Students work with me to achieve class goals.	1	2	3	4	5

بيان Statement	أبداً Almost Never	نادراً Seldom	أحياناً Some- times	غالبا Often	دائماً Almost Always
المساواة EQUITY					
يُعطي الأستاذ اهتماماً لأسئلتني كالاتمام الذي يعطيه لأسئلة الطلاب الآخرين The teacher gives as much attention to my questions as to other students' questions.	1	2	3	4	5
أحصل على نفس قدر المساعدة من الأستاذ كالتي يحصل عليها الطلاب الآخرين I get the same amount of help from the teacher as do other students.	1	2	3	4	5
أحصل على نفس الوقت من الكلام كالذي يحصل عليه الطلاب الآخرون I have the same amount of say in this class as other students.	1	2	3	4	5
أعامل بنفس المعاملة التي يحصل عليها الطلاب الآخرون في هذا الفصل I am treated the same as other students in this class.	1	2	3	4	5
ألقى نفس التشجيع من الأستاذ كالذي يتلقاه الطلاب الآخرون I receive the same encouragement from the teacher as other students do.	1	2	3	4	5
أحصل على نفس فرص المساهمة في نقاشات الفصل كالتي يحصل عليها الطلاب الآخرين I get the same opportunity to contribute to class discussions as other students.	1	2	3	4	5
أتلقي الثناء على عملي بالقدر الذي يتلقاه الطلاب الآخرون My work receives as much praise as other students' work.	1	2	3	4	5
أحصل على نفس فرصة الإجابة على الأسئلة كالتي يحصل عليها الطلاب الآخرون I get the same opportunity to answer questions as other students.	1	2	3	4	5

شكراً لك على مشاركتك

Thank you for your participation

APPENDIX B

Attitudes towards Cooperative Learning (ACL) Questionnaire

Source of scales

Velayutham, Aldridge and Fraser (2011) and Fraser (1981)

Used with permission of the authors

Name الاسم _____ School المدرسة _____ Class الصف _____ Science Teacher المعلم _____

المواقف في التعامل مع التعلم التعاوني

Attitudes towards Cooperative Learning

الاتجاهات

هذه الدراسة تحتوي على عدد من البيانات عن العلوم. سوف يطلب منك رأيك حول هذه البيانات. لا يوجد اجابة "صح" أو "خطأ". ضع دائرة حول قيمة رقمية محددة المواقف كيف تشعر حيال كل بيان. يرجى وضع دائرة واحدة فقط في كل بيان.

Instructions

This study contains a number of statements regarding science. Your opinion is what we will be asking for. There is no "right" or "wrong" answer. For each statement, put a circle on one of the numerical statements which represent your feelings towards that statement. **Please circle only ONE response for each statement.**

1 = لا أوافق بشدة Strongly Disagree (SD)

2 = لا أوافق Disagree (D)

3 = غير متأكد Uncertain (U)

4 = أوافق Agree (A)

5 = أوافق بشدة Strongly Agree (SA)

بيان Statement	لا أوافق بشدة SD	لا أوافق D	غير متأكد U	أوافق A	أوافق بشدة SA
الكفاءة الذاتية SELF-EFFICACY					
أستطيع معرفة كيفية القيام بعمل صعب I can figure out how to do difficult work.	1	2	3	4	5
أستطيع إتقان المهارات التي يتم تدريسها I can master the skills that are taught.	1	2	3	4	5
حتى لو كان عمل العلوم صعب, يمكنني تعلم Even if the science work is hard, I can learn it.	1	2	3	4	5

بيان Statement	لا أوافق بشدة SD	لا أوافق D	غير متأكد U	أوافق A	أوافق بشدة SA
أستطيع إكمال عمل صعب اذا حاولت I can complete difficult work if I try.	1	2	3	4	5
سوف أحصل على درجات جيّدة I will receive good grades.	1	2	3	4	5
يمكنني معرفة العمل الذي نقوم به I can learn the work we do.	1	2	3	4	5
يمكنني فهم المحتويات المدرّسة I can understand the content taught.	1	2	3	4	5
أنا جيد في هذا الموضوع (العلوم) I am good at this subject (science).	1	2	3	4	5
التنظيم الذاتي SELF-REGULATION					
أعمل بجدّ حتى لو كنت لا أحب العمل الذي أقوم به I work hard even if I do not like what I am doing.	1	2	3	4	5
أواصل عملي حتى لو كان هناك أشياء أفضل للقيام بها I continue working even if there are better things to do.	1	2	3	4	5
أركّز في الفصل كي لا أفوت نقاط مهمة I concentrate in class so I don't miss important points.	1	2	3	4	5
أتم عملتي وواجبي في الوقت المحدّد I finish my work and assignments on time.	1	2	3	4	5
لا أستسلم حتى لو كان العمل صعباً I don't give up even when the work is difficult.	1	2	3	4	5
أستمر في العمل حتى أنهى ما طلب مني فعله I keep working until I finish what I am supposed to do.	1	2	3	4	5
حتى لو كانت المهام غير مثوقة, أستمر في العمل Even when tasks are uninteresting, I keep working.	1	2	3	4	5

بيان Statement	لا أوافق بشدة SD	لا أوافق D	غير متأكد U	أوافق A	أوافق بشدة SA
أركّز في الفصل I concentrate in class.	1	2	3	4	5
التوجيه هدف التعلم LEARNING GOAL ORIENTATION					
أحد أهدافي هو أن أتعلم قدر ما أستطيع One of my goals is to learn as much as I can.	1	2	3	4	5
أحد أهدافي هو تعلم محتوى جديد للعلوم One of my goals is to learn new science content.	1	2	3	4	5
أحد أهدافي هو إتقان مهارات علمية جديدة One of my goals is to master new science skills.	1	2	3	4	5
فهم الافكار العلمية مهم بالنسبة لي Understanding science ideas is important to me.	1	2	3	4	5
من المهم بالنسبة لي أن أحسن مهاراتي العلمية It is important for me that I improve my science skills.	1	2	3	4	5
من المهم أن أفهم عملي It is important that I understand my work.	1	2	3	4	5
من المهم بالنسبة لي تعلم محتوى العلوم التي يتم تدريسها It is important for me to learn the science content that is taught.	1	2	3	4	5
من المهم أن أفهم ما يتم تدريسه لي It is important that I understand what is being taught to me.	1	2	3	4	5
قيمة المهمة TASK VALUE					
ما أتعلم ممكن استخدامه في حياتي اليومية What I learn can be used in my daily life.	1	2	3	4	5
ما أتعلم هو مشوق What I learn is interesting.	1	2	3	4	5

بيان Statement	لا أوافق بشدة SD	لا أوافق D	غير متأكد U	أوافق A	أوافق بشدة SA
ما أتعلم مفيد بالنسبة لي كي أعرف What I learn is useful for me to know.	1	2	3	4	5
ما أتعلم مفيد بالنسبة لي What I learn is helpful to me.	1	2	3	4	5
ما أتعلم يرضي فضولي What I learn satisfies my curiosity.	1	2	3	4	5
ما أتعلم يشجعني على التفكير What I learn encourages me to think.	1	2	3	4	5
ما أتعلم مرتبط بي What I learn is relevant to me.	1	2	3	4	5
ما أتعلم ذو قيمة عملية What I learn is of practical value.	1	2	3	4	5
الأثر الاجتماعي SOCIAL IMPLICATIONS					
الأموال التي تنفق على العلوم تستحق الانفاق Money spent on science is well worth spending.	1	2	3	4	5
يجب على الحكومة انفاق المزيد من الاموال على البحث العلمي The government should spend more money on scientific research.	1	2	3	4	5
العلوم تساعد على جعل الحياة أفضل Science helps to make life better.	1	2	3	4	5
المال العام المستخدم على العلوم في السنوات القليلة الماضية قد تم استخدامه على نطاق واسع Public money spent on science in the last few years has been used widely.	1	2	3	4	5
الاكتشافات العلمية لديها من الايجابيات أكثر من السلبيات Scientific discoveries are doing more good than harm.	1	2	3	4	5
هذا البلد ينفق ما يكفي من المال على العلوم This country is spending enough money on science.	1	2	3	4	5

بيان Statement	لا أوافق بشدة SD	لا أوافق D	غير متأكد U	أوافق A	أوافق بشدة SA
يمكن للعلوم ان يساعد على جعل العالم مكاناً أفضل في المستقبل Science can help to make the world a better place in the future.	1	2	3	4	5
الأموال المستخدمة في المشاريع العلمية جديرة بالاهتمام Money used on scientific projects is worthwhile.	1	2	3	4	5
المشاركة ENGAGEMENT					
أشارك في الاجابة على أسئلة المعلم I engage in answering the teacher's questions.	1	2	3	4	5
شاركت في مناقشات الفصل I am involved in class discussions.	1	2	3	4	5
أشارك في عمل بحثي I am involved in inquiry work.	1	2	3	4	5
شاركت في بحث استقصائي I am involved in investigations.	1	2	3	4	5
أشارك في مناقشة جماعية I am involved in collaborative discussion.	1	2	3	4	5
أشارك في عمل تجارب I am involved in experiments.	1	2	3	4	5
أشارك في التدريب العملي على الأنشطة I am involved in hands-on activities.	1	2	3	4	5
أشارك في عمل جماعي I am involved in group work.	1	2	3	4	5
اعتماد الاتجاهات العلمية ADOPTION OF SCIENTIFIC ATTITUDES					
أستمتع بقراءة المواضيع التي لا تتفق مع أفكاري السابقة I enjoy reading about things that disagree with my previous ideas.	1	2	3	4	5

بيان Statement	لا أوافق بشدة SD	لا أوافق D	غير متأكد U	أوافق A	أوافق بشدة SA
أجد أنه من المثير للاهتمام ان نسمع عن أفكار علمية جديدة I find it interesting to hear about new scientific ideas.	1	2	3	4	5
أحب أن أستمع الى آراء ناس آخرين I like to hear other peoples' opinions.	1	2	3	4	5
لدي الفضول بمعرفة العالم الذي نعيش فيه I am curious about the world in which we live.	1	2	3	4	5
أحب الاستماع الى الناس التي تتعارض أفكارهم مع أفكاري I like to listen to people whose opinions are different from mine.	1	2	3	4	5
معرفة أشياء جديدة هو شئ مهم Finding out about new things is important.	1	2	3	4	5
في التجارب العلمية, أحب أن استخدم طرق جديدة لم أستخدمها من قبل In science experiments, I like to use new methods which I have not used before.	1	2	3	4	5
في التجارب العلمية, أبلغ عن نتائج غير متوقعة فضلاً عن تلك المتوقعة In scientific experiments, I report unexpected results as well as expected ones.	1	2	3	4	5
تطلعات مهنة العلوم SCIENCE CAREER ASPIRATIONS					
من شأن مهنة في مجال العلوم أن تكون مثيرة A career in science would be exciting.	1	2	3	4	5
العمل في مختبر علمي, مستشفى أو مكتب هندسي أو موقع من شأنه أن يكون وسيلة مهمة لكسب لقمة العيش Working in a science laboratory, a hospital, or an engineering office or site would be an interesting way to earn a living.	1	2	3	4	5

بيان Statement	لا أوافق بشدة SD	لا أوافق D	غير متأكد U	أوافق A	أوافق بشدة SA
من شأن العمل كعالم أن يكون مثيراً للاهتمام A job as a scientist would be interesting.	1	2	3	4	5
عندما أنهى دراستي ، أود أن العمل مع الناس الذين يصنعون الاكتشافات في مجال العلوم When I leave school, I would like to work with people who make discoveries in science.	1	2	3	4	5
العمل في مختبر للعلوم من شأنه أن يكون وسيلة مثيرة للاهتمام لكسب لقمة العيش Working in a science laboratory would be an interesting way to earn a living.	1	2	3	4	5
عندما أنهى دراستي أود أن أريد تدريس العلوم I would like to teach science when I leave school.	1	2	3	4	5
عندما أنهى دراستي أود أن أصبح عالماً I would like to be a scientist when I leave school.	1	2	3	4	5
عندما أنهى دراستي ، أود أن أعمل في مجال الصحة، الهندسة، العلوم البيئية، البحوث الطبية أو تدريس العلوم When I leave school, I would like to work in health, engineering, environmental science, medical research or science teaching.	1	2	3	4	5

شكراً لك على وقتك ومشاركتك

Thank you for your time and participation

APPENDIX C

Teacher Interview Protocol

Please note: Cooperative learning was referred to as COLA (cooperative learning and assessment) in Abu Dhabi.

Teacher Interview Questions

Thank you for your attendance and participation in this interview today. The purpose of this discussion is to gain further insight into your experiences, thoughts, opinions and feelings on the implementation of cooperative learning and assessment. You have been selected because you are the best person (people) to get valuable feedback from since you have been implementing COLA for over a year now. Confidentiality is guaranteed in this study where none of your personal information (name, school, etc.) will be disclosed in the write-up. This interview will be audio recorded and the results used to contribute important details as well as marry up the information to fill in gaps from the student data. This interview will take approximately 30 minutes. Do you have any questions?

I will now ask you some questions. Could you please answer these from your personal experiences.

1. What have been some successes (positives) of implementing COLA in your lessons?
2. What are some challenges you have faced whilst implementing COLA?
3. Do you think students enjoyed working in groups over working individually?
4. In terms of assessment, what is your opinion on group assessments?
5. I know this varies amongst teachers, topics, etc. but on average, how many times did students actively work in groups in your lessons per week (out of the 4 lessons)?
6. A) In your opinion, which aspects of COLA did students enjoy the most? B) Which aspects were not as enjoyable for students?
7. Students were grouped according to abilities. a) How was this positive for students and yourself? B) Can you give me some examples where this was not so positive or suitable?
8. A) From your observations, are your students engaged even if they don't enjoy the tasks/topics being covered? B) If you felt like they were not engaged, which strategies did you use to get them interested/engaged?

9. Are there any new approaches you tried that you would use again?
10. Are there any new approaches you wanted to try but were unable to? If so, what are these?
11. In comparison to when students worked alone, were students more engaged in the group work?
12. Were there any evident changes to student attitudes towards science lessons as the year progressed? Can you explain?
13. A) If implementing COLA was not a requirement by ADEC for next year, would you still implement this in your teaching and learning? B) Which aspects would you change?

Thank you for your invaluable and helpful contributions today.

APPENDIX D

Information Sheet and Consent Form: Teacher



Curtin University
School of Science and Engineering

Participant information sheet - Teacher

Cooperative learning in science classes in the United Arab Emirates: Learning environment, attitudes, motivation, engagement and career aspirations.

My name is Nadine Khalil. I am currently completing a piece of research for my Doctor of Science Education degree at Curtin University of Technology.

Purpose of Research

I am investigating the impact of cooperative learning and assessment in science classes in the United Arab Emirates: Students' perceptions of the learning environment, attitudes, motivation, engagement and aspirations.

Your Role

I am interested in finding out about what successes and challenges you are facing as you implement the cooperative learning and assessment teaching and learning strategies in your lessons. You will be required to keep a reflective journal/diary documenting these successes and challenges as well as sample activities, tasks and lesson plans. I will also ask you to participate in an interview on your views of cooperative learning and assessment, a process which will take approximately 30 minutes. Some lessons will also be observed to look at student interactions, engagement levels, attitudes towards tasks and group work.

Consent to Participate

Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights and responsibilities. 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 information you provide will be kept separate from your personal details, and only myself and my supervisor will have access to this. The surveys and interview transcript will not have your name or any other identifying information on it and in adherence to university policy, the surveys, interview tapes and transcribed information will be kept in a locked cabinet for at least five years, before a decision is made as to whether it should be destroyed.

Further Information

This research has been reviewed and given approval by Curtin University Human Research Ethics Committee (Approval Number SMEC-11-13). Should you wish to make a complaint on ethical grounds email hrec@curtin.edu.au. If you would like further information about the study, please feel free to contact me on 0566029551 or by email nadine.khalil@adec.ac.ae. Alternatively, you can contact my supervisor Dr. Jill Aldridge at j.aldridge@curtin.edu.au

Thank you very much for your involvement in this research.

Your participation is greatly appreciated.

CONSENT FORM - Teacher

Cooperative learning in science classes in the United Arab Emirates: Learning environment, attitudes, motivation, engagement and career aspirations.

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: _____

Signature: _____

Date: _____

APPENDIX E

Information Sheet and Consent Form: Student

Curtin University
School of Science and Engineering



Participant information sheet - Student

Cooperative learning in science classes in the United Arab Emirates: Learning environment, attitudes, motivation, engagement and career aspirations.

My name is Nadine Khalil. I am currently completing a piece of research for my Doctor of Science Education degree at Curtin University of Technology.

Purpose of Research

I am investigating the impact of cooperative learning and assessment in science classes in the United Arab Emirates: Students' perceptions of the learning environment, attitudes, motivation, engagement and aspirations.

Your Role

I am interested in finding out what you think about the science learning environment. You will be required to complete two surveys and might be asked to participate in an interview. The surveys will be administered on two occasions and will take between 25-40 minutes each. The interview process will take approximately 15 minutes.

Consent to Participate

Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights and responsibilities. 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 information you provide will be kept separate from your personal details, and only myself and my supervisor will have access to this. The surveys and interview transcript will not have your name or any other identifying information on it and in adherence to university policy, the surveys, interview tapes and transcribed information will be kept in a locked cabinet for at least five years, before a decision is made as to whether it should be destroyed.

Further Information

This research has been reviewed and given approval by Curtin University Human Research Ethics Committee (Approval Number SMEC-11-13). Should you wish to make a complaint on ethical grounds email hrec@curtin.edu.au. If you would like further information about the study, please feel free to contact me on 0566029551 or by email nadine.khalil@adec.ac.ae. Alternatively, you can contact my supervisor Dr. Jill Aldridge at j.aldridge@curtin.edu.au

Thank you very much for your involvement in this research.

Your participation is greatly appreciated.

CONSENT FORM - Student

Cooperative learning in science classes in the United Arab Emirates: Learning environment, attitudes, motivation, engagement and career aspirations.

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name and address will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

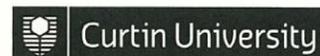
Name: _____

Signature: _____

Date: _____

APPENDIX F

Ethics Approval: Curtin University



Memorandum

To	Nadine Khalil, SMEC
From	Pauline Howat, Administrator, Human Research Ethics Science and Mathematics Education Centre
Subject	Protocol Approval SMEC-11-13
Date	5 April 2013
Copy	Jill Aldridge, SMEC

Office of Research and Development
 Human Research Ethics Committee
 Telephone 9266 2784
 Facsimile 9266 3793
 Email hrec@curtin.edu.au

Thank you for your "Form C Application for Approval of Research with Low Risk (Ethical Requirements)" for the project titled "*Investigating the impact of cooperative learning and assessment in science classes in the United Arab Emirates: Students' perceptions of the learning environment, attitudes, self-efficacy, engagement and aspirations*". On behalf of the Human Research Ethics Committee, I am authorised to inform you that the project is approved.

Approval of this project is for a period of twelve months **3rd April 2013 to 2nd April 2014**.

The approval number for your project is **SMEC-11-13**. *Please quote this number in any future correspondence.* If at any time during the twelve months changes/amendments occur, or if a serious or unexpected adverse event occurs, please advise me immediately.

PAULINE HOWAT
 Administrator
 Human Research Ethics
 Science and Mathematics Education Centre

Please Note: The following standard statement must be included in the information sheet to participants:

This study has been approved under Curtin University's process for lower-risk Studies (Approval Number SMEC-11-13). This process complies with the National Statement on Ethical Conduct in Human Research (Chapter 5.1.7 and Chapters 5.1.18-5.1.21).

For further information on this study contact the researchers named above or the Curtin University Human Research Ethics Committee. c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au.

APPENDIX G

Cooperative Learning Booklet

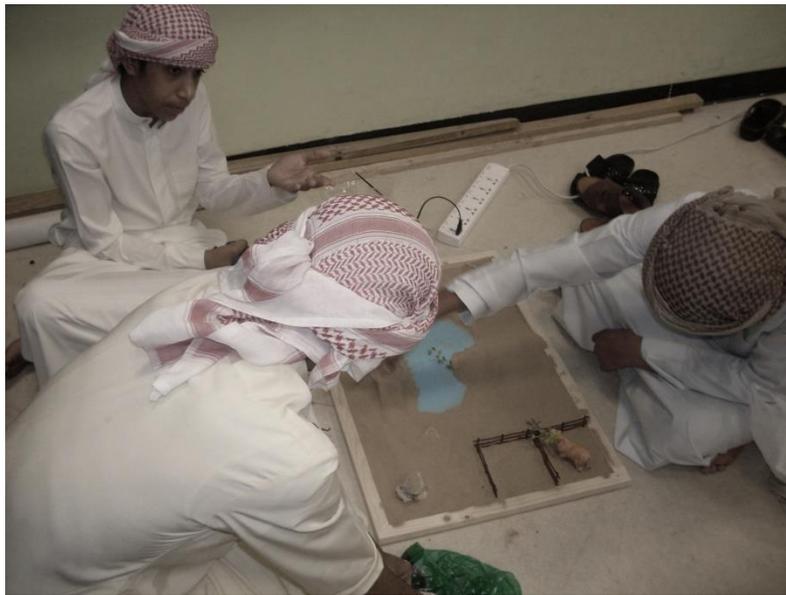
Establishing Learning Teams

(Some ideas to help)

COLA

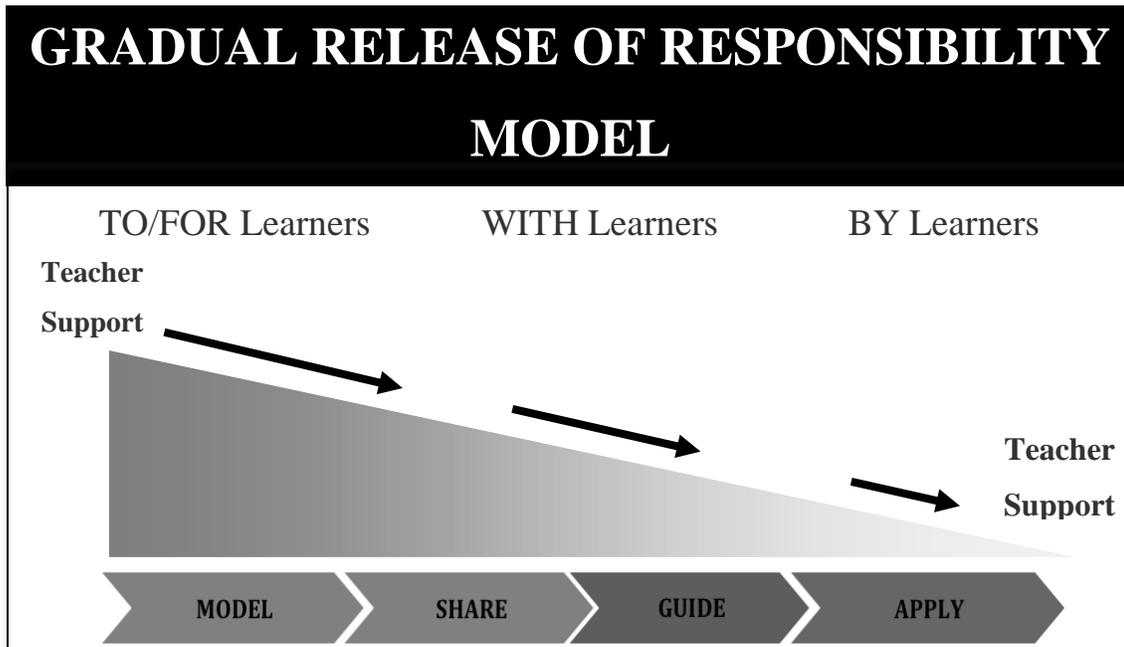
(Cooperative Learning and Assessment)

A Teaching Strategy:



Student-centred learning

Introduction



Background

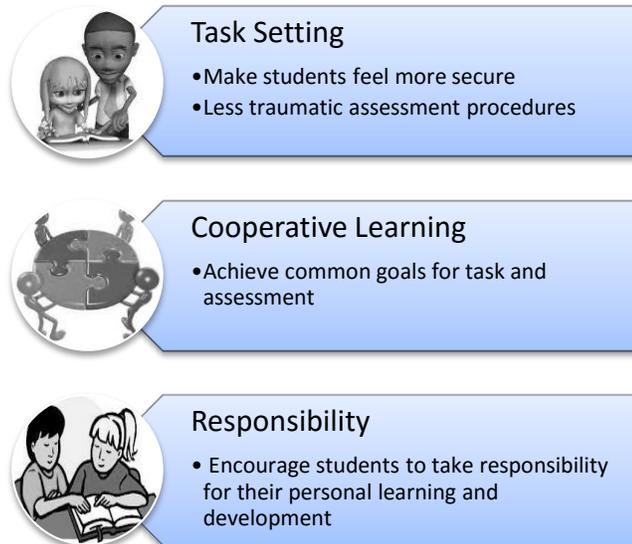
COLA will be used extensively in Cycle 2 and 3 Science subjects. The following material gives some background on protocols for team establishment, along with some strategies to help the team make good progress. We will refer to the ‘groups’ as ‘teams’ during this work.

Outline

The COLA approach is designed to improve student attitudes and learning outcomes. It is easy to implement in the secondary school classroom and has no impact on teacher workload or curriculum content. It has been extensively trialled over many years and the data collected with appropriate academic rigor shows a very positive effect on student attitudes.

Aims and Objectives

The following guidelines are a number of suggestions, which have been found to help the group enjoy working together more effectively, and gain more rewards both individually and as a learning team:



Task Setting

- Make students feel more secure
- Less traumatic assessment procedures

Cooperative Learning

- Achieve common goals for task and assessment

Responsibility

- Encourage students to take responsibility for their personal learning and development

Protocol for Group Establishment and Organisation

Teachers will use the following guidelines in the setting up and operation of the groups within their classrooms. There will be plenty of opportunity to use any of the cooperative learning ideas from researchers such as the Johnsons and Kagan that have been used in this school. It is most important to ensure that these are kept simple and have minimal impact on the individual teacher's workload.

Following the guidelines are a number of suggestions, which have been found to help the group enjoy working together more effectively, and gain more rewards both individually and as a learning team.

It is envisaged that the students will do the majority of their assessments in their groups but the end of year examination will be taken as individuals. Some written tests will be done as individuals, which can be diagnostic to track student progress.

Protocols for Group Establishment and Organisation

Student Instructions

- 1 Students are able to select their own group of preferably three but no more. The students usually select students of similar ability to work with which helps with task differentiation. Some teachers have selected the groups on ability as a first step. Teacher selected groups of one top student with two weaker ones does not work! Cycle 3 students can cope with four in a team.
 - 2 They are to do all practical, fieldwork, assignments and tests working in these groups.
 - 3 Each member of the group receives the same mark for tests, assignments, fieldwork and for any other assessment.
 - 4 All work and assessment is essentially cooperative, students are encouraged to share the workload and enjoy working together, whether it is an assessed activity or a simple practical exercise.
 - 5 Students will be instructed in suitable ways of ensuring that all group members participate and have a sense of ownership of the results. For example, tasks such as collecting and using equipment are always rotated to make sure that everyone has a turn. These 'roles' are defined as: Manager: Technician: Recorder/reporter, descriptions follow.
 - 7 Students are instructed to ensure that each group member is given a specific task and that they are responsible for completing that task on time. The group then collates all of the contributions from each group member (this is often one member's task). The master assignment is marked and each member receives the same mark along with a copy of the final assignment
 - 8 For written tests, students are arranged in their groups at the desks to allow them to work together with a minimum of contact with other groups. Eye contact should be possible among group members. Talk within the group is permissible but talk between groups is not. Answers are to be handed in and marked. All group members receive the same grade.
-

Teacher Instructions

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

Group Work Role Descriptions:**All Students will:**

- Be active in achieving the group goal.
- Participate in group work
- Play a different role in each project based on teacher instructions
- Communicate appropriately with group members, other groups, and the teacher
- Be responsible for the team, for checking-up on each other, and helping each other out.

Roles: Manager: Technician: Recorder/reporter if there are only two students then the role of manager can be combined with Recorder/reporter

Manager:

- Diplomatically works with the group to break responsibilities with and amongst team-mates.
- Ensure that tasks are finished in appropriate time and guide team-mates to meet deadlines**
- Check all work over, prior to submission, with team-mates
- Generate a consensus within the group
- Ensure that all team members are actively participating

Technician:

- Lead the organization of the problem solving process and log this process
- Perform major parts of the experiment and lead data collection
- Share insights and new discoveries regarding course content and will reflect on the problem solving process.

Recorder:

- Keeps records of instructions, takes notes in collaboration with the team, what the team has completed.
- Prepares the final written report and documentation in consultation of the group.

Reporter:

- Represents the group
- Shares the groups ideas once the group has come to an agreement
- Represents the group in presentations and discussions
- Will fully understand the group's vision, methods, etc such that she can represent for the group without relying on the group in formal presentations or discussions (based on teacher instruction).

Time Manager: (Maybe taken by manager)

- Ensured tasks are completed in a timely fashion and guides team members on meeting deadlines
- Ensures Active participation of all team members during the lesson.

Group Responsibilities

Students are expected to take responsibility for their own learning and day to day organisation

Team Book

The team book is often a simple clear file or folder. It is kept at school and collected each day by a team member. It should contain:

1. A good team name on the front page of the team book and perhaps team photograph and a short biography of the team members.
2. A hard copy of the task
3. Complete daily contract sheet outlining “Learning Intentions” for their team that day this includes individual roles and attendance records.
4. Planning sheets (often A3 folded in half for the team book)
5. Useful reference material, newspaper cuttings etc.
6. Assessments and reports from the teacher or other teams in the case of peer assessment.
7. Reflections by students at the end of units are also to be encouraged.
8. Teachers can check the team books on a regular basis.

Team sign on

Once teams are established a daily sign on at the white board helps them take responsibility, use a permanent marker or a laminated card for use with a white board marker.

- Team sign in on white board ie 10 slots for team members to record each member present as a tick and write the names of anyone who is absent
- The duty team can have extra responsibility such as handing out equipment, running a quiz etc.
- A running points tally for short quizzes, exemplary work, helping others etc. can be for entire unit.

Skills are the Key!

Skills Each Group Will Be Assessed on.

**Evaluating and
Reflecting**

**Inquiring and
Experimenting**

Remembering

**Understanding and
Analysing**

Participating

Creating

Handling and Research

Implementation Strategies

League Tables and Group Names

- The students certainly enjoy naming their group or learning team and come up with some imaginative titles.
- A natural extension of this is the introduction of 'league tables' where each groups place is listed on a chart in rank order.
- The groups are given a mark according to their place in each event (any task that is marked) such as 10 for first and 1 for last.
- The teacher can set up tasks such as a practical activity and the first group with the correct response(s) provided to the teacher receives the top mark and so on.
- If there is a range of tasks, every group will have an opportunity for their moment of glory. Students enjoy this aspect of their group work and even the lower ranked students enjoy the chances they get.
- They are working together to achieve more but not on their own. An example of a league table is available at the end of this section.

Review Testing

- After students have completed a test, going over of the answers is often seen as a waste of time by students yet teachers know that reviewing where you have gone wrong in a test is very important as we learn from our mistakes.
- One of the strategies introduced to help this and build the teamwork is the review test.
- Groups are returned their test scripts with their marks including those questions to which they have incorrect responses.
- They can then be given class time to do the questions that were wrong (open book perhaps or home work).
- These are resubmitted and remarked. The group then is given an average of the first and second marks.

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

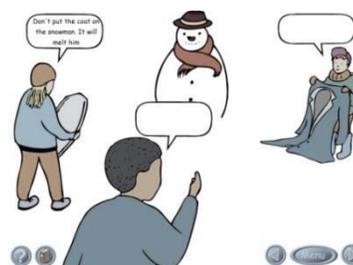
Unit Review and Student Test Design



- Teaching students how to revise for tests is an aspect of teaching often not given the priority it deserves and working on this in teams enables the students to talk among themselves and establish what in fact the key points are in a particular unit.
- They can use resources such as their notes, texts, prescribed SLO's, and of course the teacher.
- A unit summary can be presented for the group to use using mind mapping techniques.
- Student designed tests are also an effective way to help understanding of important parts of a unit.
- One way of doing this is to give each group part of a topic on which to make up a question (the time and mark value needs to be prescribed by the teacher).
- The questions from each group are then collated and the test taken in groups. The natural extension of this is for each group to mark the scripts from the rest of the class for their question and then collate the final result.

Concept Cartoons

- The use of argumentation in science through concept cartoons has proved to a valuable tool for use in cooperative group work and has been a regular part of science programmes for some time.
- Some excellent discussions among group members have led to a better understanding of concepts which students often find more difficult.
- Students and make their own concept cartoons in their teams after completing a unit. It is often fun to use their own photographs and 'PowerPoint' or 'Comic Life' software to add in their own speech bubbles. Can lead to student-designed experiments.



<http://www.angelsolutions.co.nz/products/concept-cartoons.htm>

Who wants to be a millionaire?

- This is a very popular and fun format for teams to review units of work, rotate around the groups with 10 points for a correct answer, if they do not answer correctly open it to all teams, first team to volunteer gets 5 points for correct -5 for wrong response.
- If teams make up the questions they are not eligible to answer.

Debates

- These are very effective and encourage several teams to work together and a lot of fun.
- Can be done at the end of and inquiry.

- It is most effective if the formal debating protocols are followed, perhaps involve the English teachers.

General Guidelines: Implementing COLA

- Complete the getting to know you student profile sheet. Gives great info on student background and interests.
- Share (appropriate) some of your life history with students. They love it.
- Make sure that there are enough activities to keep every team member busy.
- Activities should have an appropriate level of scaffolding so that students of all levels can work independently.
- Do an **activity every period** right from the start that you can reinforce COLA expectations with (not always a practical)
- Wait 2-3 weeks before setting up permanent groups. Use 10 different coloured cards (3 of each) and randomly select groups for the first 3 weeks so students get a chance to work with others
- Your activities **must not always be academic focus ones** (otherwise certain groups or individuals will dominate)
- Have your wall chart that records points up early
- Make some activities **completion ones** rather than first finished so all groups can obtain maximum points
- Some starter activities
 - Show them 20 pieces of lab equipment, one minute to observe them and then each group writes down as many as they can (can discuss afterwards how working together might mean you can remember more)
 - Take the unit objectives or key questions and give them one minute to view them. Then each group writes down as many as

they can (can discuss afterwards how working together might mean you can remember more)

- Using balances to find the mass of selected objects
 - Listing observations of for example, magnesium burning
 - Building a tower that supports a marble using 25 straws and 1 metre of cellotape
- Awarding points can vary in method and activity from class to class. More able students thrive on competition so 10 **quick** questions at the start of every period works well (as long as you don't discuss answers and take too much time). Award 5 points to the group(s) who got 9-10 right, 4 points for 7-8 right etc) For less able students, give instant rewards for the group who pack up first for example
 - Marking only one of the group's workbook and using that mark for all 3 students works quite well and student's tend to "correct" their members if the book is not up to speed. Means that you only have to mark 10 books as well.
 - When you mark classwork, don't write in the correct answers – indicate where the mistake is and get groups to correct their own work at the beginning of the next lesson.
 - When you mark classwork, give written comments and praise and guidance rather than a numerical mark – this prevents confusion / argument when CA marks are decided.
 - Make some assessments open book and some presentations as per Pluto style
 - Get into IT based inquiry ASAP. Many "challenging students become totally different with a new approach)
 - If it doesn't seem to be working, give it a rest for a time as it is a strategy, not the strategy for effective teaching
 - If a student is reluctant to contribute, then isolate the student to work on their own and remove the privilege of doing the next practical or interesting activity. They soon want to be part of it all again.

- Number each “table” of three students for ease of instructions and to allow for multiple activities ie 3 groups on computers, 3 on written exercise and 3 on activity (the one I usually have to be with) and then we rotate.
- Try and get at least one other teacher to be doing what you are doing as you can plan together and share successes and failures.

Appendix

An Example of a League Table (Wall Chart)



Grade 7S 1

Number	Learning Team Name	ASSESSMENT EVENT and POINTS (10 for 1 st Place, 1 for 10 th)					
		Test1	Prac 1	Test 2	Issue	Test 3	Total
		Chem.	Sherlock	Phys.	Invest.	Bio.	Place
1	FALCONS	10	2	8	5	6	31 4 th
6	SARACENS	9	7	9	7	7	39 1 st =
7	CAMELS	8	9	10	4	8	39 1 st =
8	LAND CRUISER	7	1	5	3	10	26 5 th
9	The MALL	6	4	7	10	9	36 3 rd
10	HURRICANES	5	3	6	9	2	25 6 th
2	DESERT DWELLERS	4	10	4	1	1	20 8 th
3	SPACE TRAVELERS	3	5	1	8	5	22 7 th =
4	SCIENTISTS	2	8	3	2	4	19 9 th
5	FISHERMEN	1	6	2	6	3	18 10 th =