Science and Mathematics Education Centre

Effectiveness of Using Teaching Strategies to Engage Adult Male Students Who Had Previously Experienced Childhood Difficulties in Learning Mathematics

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any 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.

Signature:

Date: August 2013

Abstract

The main purpose of this study was to investigate the effectiveness of teaching strategies that engage college students who experienced childhood difficulties in learning mathematics in the United Arab Emirates (UAE) in terms of the nature of the classroom learning environment and students' satisfaction. In addition, I investigated how the use of personally-relevant and concrete activities changed the learning environment in ways that were perceived to be beneficial by adults who had experienced failure.

A sample of 84 students from eight classes in the Higher Colleges of Technology (HCT) were involved. The learning environment was assessed as a pretest and posttest with a modified Arabic version of four scales (Involvement, Task Orientation, Personalisation and Individualisation) from the College and University Classroom Environment Inventory (CUCEI). Satisfaction was measured with a modified Arabic version of this scale from the CUCEI. Moreover, five case studies of students were conducted to assess the learning environment through observations, semi-structured interviews and focus-group interviews and to link qualitative information with the constructs assessed by the CUCEI.

Principal axis factoring with varimax rotation and Kaiser normalisation supported an optimal factor structure for a 16-item 4-scale version (4 items per scale) of the CUCEI assessing Involvement, Task Orientation, Personalisation and Individualisation. The total percentage of variance accounted for by the four CUCEI scales was nearly 60%. The internal consistency reliability, using Cronbach's alpha coefficient, was calculated for each learning environment scale and Satisfaction for two units of analysis, namely, the individual student and the class mean. Reliabilities were calculated separately for pretest and posttest data with both the student and the class mean as the units of analysis. Alpha coefficients for the four scales ranged from 0.61 to 0.75 for the pretest and from 0.64 to 0.79 for the posttest. With the class mean as the unit of analysis, alpha coefficients ranged from 0.61 to 0.77 for the pretest and from 0.63 to 0.82 for the posttest.

MANOVA and effect sizes were used to provide information about the statistical significance and magnitude of the pretest–posttest changes for each scale. Changes were statistically significant and large in magnitude for Involvement (effect size of 2.40 standard deviations), Task Orientation (effect size of 2.38 standard deviations), Personalisation (effect size 2.44 standard deviations), Individualisation (effect size 1.40 standard deviations) and Satisfaction (effect size 2.88 standard deviations).

Data from the CUCEI were complemented by qualitative information gathered from case study students through class observations, interviews with participants and narrative stories which allowed triangulating the results from the two methods. The qualitative data provided valuable insights about how the activity-based teaching strategies changed adult male students' perceptions towards learning mathematics after having experienced failure in the past. Overall, the effectiveness of the activity-based teaching strategies was supported by the magnitudes and statistical significance of pre–post changes in the quantitative questionnaire data, together with the qualitative data.

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Chapter 1

INTRODUCTION AND OVERVIEW

1.1   Introduction

The study reported in this thesis focused on the effectiveness of teaching strategies that engage college students who have experienced childhood difficulties and failure in mathematics classes. Focusing on students' perceptions of the classroom learning environment and their satisfaction, my study involved a pre–post design that encompassed the collection of both quantitative and qualitative data. Quantitative data collection involved the use of a survey to examine students' perceptions of their mathematics learning environment and satisfaction with their mathematics class. Qualitative methods, including observations and interviews, were used to provide more in-depth information about how the use of personally-relevant, concrete activities changed the learning environment in ways that were perceived to be beneficial by the adult male students.

This chapter provides an introduction to and overview of the research using the following headings:

- Background to the Study (Section 1.2);
- Teaching and Learning in the UAE (Section 1.3);
- Research Questions (Section 1.4);
- Context of the Study (Section 1.5);
- Theoretical Framework (Section 1.6);
- Significance of the Study (Section 1.7); and
- Overview of the Thesis (Section 1.8).

1.2   Background to the Study

As a lecturer of mathematics at the Higher Colleges of Technology (HCT) in Abu Dhabi, United Arab Emirates (UAE), I have observed the many difficulties that my adult male Emirati students have in grasping basic principles of mathematics. These observations inspired me to devise and implement alternative teaching methods for these students. In this respect, this study was born from the real-world learning and teaching challenges that occurred in my class of adult male students.

To provide a backdrop for this study, this section provides an overview of: the UAE (Section 1.2.1); the education system in the UAE (Section1.2.2); primary and secondary education (Section 1.2.3); higher education in the UAE (Section 1.2.4); and teaching in the UAE (Section 1.2.5).

1.2.1   The UAE

The UAE is located on the Arabian Gulf, east of Saudi Arabia and north of Oman. Bradshaw, Tennant and Lydiatt (2004) claim that the country has a long history of local tribal lifestyle and, later, of European influences. Over the past 40 years, the UAE has grown from a small country in the Middle East into a modern metropolitan area within the region. The UAE is comprised of seven emirates: Abu Dhabi (the capital city), Dubai, Sharjah, Ras Al Khaimah, Umm Al Quwain, Fujairah and Ajman. Over the past few decades, the UAE has emerged into the mainstream of modernism, as a result of a healthy economy driven by oil, gas and, more recently, tourism.

In 2010, the population of UAE was estimated to be 4.9 million, with almost 20% of the population being UAE citizens (Emirati nationals) and the remaining 80% being expatriates (foreigners). A majority of the foreigners in the UAE are South Asians (approximately 50%), followed by Arabs and Iranians (approximately 23%) and Europeans and other Westerners (approximately 8% of the total population) (Central Intelligence Agency–The World FactBook, 2009).

1.2.2 Education System in the UAE

When comparing the education system of the UAE with systems of education in other countries, its development is relatively new. Prior to the 1950s, home schooling was common and a great emphasis was placed on religious studies. At this time, education generally included studying the Holy Quran, writing, arithmetic and Arabic calligraphy. Bradshaw et al. (2004) reported that, in 1952, public schooling officially began, an academic authority was established to oversee the national curriculum and subjects, beyond religious studies, were included into the education system.

The public school curriculum (as well as the textbooks) was based largely on curriculum developed in neighbouring countries, and included both the Kuwaiti and Jordanian models (Ministry of Education, 2008). In the 1960s and 1970s, the education system expanded and provided separate schools for boys and girls. This single-sex schooling still predominates within public government schools today. In all cases, female educators have been appointed for all-girl schools and male educators for all-boy schools (Bradshaw, Tennant & Lydiatt, 2004). More recently, however, female educators have been appointed for all-boy schools at the primary-school level.

The United Arab Emirates Ministry of Education (MOE) was established by the UAE government after the Declaration of Federation of the Seven Emirates in 1971 and is responsible for both the public and private schools that operate within the seven emirates (Gaad, Arif & Scott, 2006).

For public school system, the Ministry of Education assumes a broad set of roles, similar to those of Ministries of Education in other countries. They are responsible for: buildings and infrastructure; hiring staff; determining the standards of education; providing curriculum materials; and ensuring that adequate programs are operating (Bradshaw, Lydiatt &Tennant, 2004).

For the private schools, the Ministry for Education oversees the licensure and assumes more of a supervisory role within the private education system. It ensures that the basic requirements of the school are met, including the physical components of the site, and that the educational programs are appropriate.

Within each emirate, an Education Council ensures that the educational quality within the private and public educational institutions (including early learning centres, training institutions and universities) is up to standard.

The Abu Dhabi Education Council (ADEC) is an independent Abu Dhabi-based corporate body which was established by Sheikh Khalifa in 2005. ADEC has been entrusted with the task of developing education and educational institutions in the emirate. The council works closely with the Ministry of Education in formulating the emirate's education plan within the framework of the UAE's general education policy (UAE Interact, 2011). Federal public schools (including kindergartens) are free of charge for UAE citizens. They are easily accessible as they are well distributed geographically.

Over 40% of the students in the UAE attend private schools. Some of these offer foreign language education that is geared towards expatriate communities and follows the curriculum of the students' countries of origin. A Federal Cabinet decision, issued in 2001, which excluded expatriate students from government schools, was rescinded in mid-2006. Commencing in the academic year 2006/07, admission for expatriate students was based on merit and fees were levied. As a result, many expatriate students have returned to public schools.

1.2.3   *Primary and Secondary Education in the UAE*

The educational structure in the UAE, which was established in the early 1970s, is a four-tier system covering 14 years of education. In this system, children aged 4 to 5 years attend kindergarten, from ages 6 to 11 years they attend primary school, from ages 12 to 14 they attend the preparatory stage, and from ages 15 to 17 years they

attend secondary school. Education at the primary and secondary levels is compulsory up to ninth grade (age 14).

According to Hassan (2008), public kindergartens follow the federal curriculum which had been updated and improved in 2003 but remains weak in the teaching of the Arabic and English languages. The MOE requires kindergartens to use the latest methods of teaching which involve games, communication and a free learning environment (i.e. students are free to ask questions during the lesson and participate in activities), with the aim of developing the student's self-confidence (Hassan, 2008).

Primary education is for six years and is divided into two three-year cycles: the basic or junior primary stage, for which one teacher has a single class all through the day; and the senior primary stage, for which there are different teachers for the different school subjects. The preparatory stage includes Grades 7 to 9 of the first primary sequence or Forms I to III of the preparatory stage. The school year extends over 32 weeks. Core subjects in the junior primary stage include Islamic education, Arabic language, English language, mathematics and science. Activity subjects comprise art, physical education, music and family education for girls. The same subjects are taught at the senior primary stage, but the number of periods for some of them is increased. At the senior stage, social studies is included as a compulsory subject. The same subjects are taught at the preparatory stage, with an increase in the amount of content and number of class periods. At this stage, social studies is divided into the three separate units of history, geography and civics (United Arab Emirates, 2011b).

The preparatory stage lasts three years and caters for students aged 12 to 14 years. This stage qualifies students for universal or technical secondary education. The general secondary stage lasts for three years and caters for students aged 15 to 17 years. After the first year of core subjects, students can choose to follow either a science or a literary stream. Technical education is comprised of the three main streams of technical, agricultural and commercial. It is divided into two levels, one for technical preparatory education, and the other for technical, commercial and agricultural secondary education, each lasting three years. In technical education

courses, English is used for specialised subjects but all other subjects are taught in Arabic (United Arab Emirates, 2011b).

The secondary stage lasts for three years and involves a common first year, after which students choose to specialise in either science or art. At the end of the 12th year of schooling, students sit an examination called the Shahadat Al-Thanawiya Al-Amma (Secondary School Leaving Certificate). Technical secondary education offers both preparatory and secondary cycles. The preparatory cycle offers an engineering course for the acquisition of basic skills leading to the Intermediate Certificate. At the end of the secondary cycle, a Technical Secondary Diploma is awarded (United Arab Emirates, 2011b).

1.2.4 Higher Education

All Emirati nationals have access to higher education at two universities, namely, the United Arab Emirates University (UAEU) in Al Ain and the recently-founded Zayed University in Abu Dhabi and Dubai. In addition to these universities, there are 17 Higher Colleges of Technology (HCTs) campuses spread throughout the country. There are also many internationally-accredited private institutions that are being established in various parts of the UAE, such as Al Huson University and the Emirates College of Technology. The UAEU, Zayed University and the Higher Colleges are all tuition-free for Emirati nationals.

The oldest of the postsecondary institutions in the UAE, the United Arab Emirates University (UAEU), opened in 1977 in Al Ain with the five faculties of arts, science, education, political science and business administration. The Higher Colleges of Technology (HCT), established in 1988, initially offered two-year applied and vocational programs. Located in Abu Dhabi, Dubai, Sharjah, Al Ain, Ras al–Khaimah and Fujairah, they provide three years of technical training in such areas as business, administration, accounting, banking, information systems, computers, engineering, aviation technology and health sciences. There are separate HCT colleges for men and for women. These colleges are designed to prepare Emirati nationals for professional and technological careers in both government and private

sectors. Since their foundation, the colleges have grown dramatically, with staff and students increasing by about 30% each year (United Arab Emirates, 2011a).

1.2.5   *Teaching in the UAE*

This section describes the teaching qualifications required to teach in the UAE (Section 1.2.5.1) and the predominant teaching style in the UAE (Section 1.2.5.2).

1.2.5.1   *Teaching Qualifications*

The Abu Dhabi Education Council (ADEC) in the UAE stipulates that a teacher must have a Bachelor's degree, a relevant teaching qualification and at least two years of teaching experience. In some cases, lesser qualifications, such as teaching certificates, are accepted (teachAway, 2011). Most teachers in public schools are UAE nationals and most teachers in private schools are expatriates: Iraqi, Jordanian, British, American, Australian, South African, etc.

According to Edarabia (2012), the Ministry of Education announced that there were more than 1,460 public school teachers who do not hold a university degree. To overcome this (as well as to raise the profile of the teaching profession), the adviser of the Ministry of Education called for a teacher licensing procedure which would enforce minimum standards, require teachers to have qualifications in the subject that they teach and increase proficiency in Arabic and English (Edarabia, 2012).

The chairman of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) program, Gitsaki (The National, 2011**),** stated that "teachers may have bachelor's degree or master's degree but may not have had any practical training in the classroom". Therefore, Dr Gitsaki initiated a project to encourage teachers to attend professional development courses. According to the Abu Dhabi Educational Council (ADEC, 2011), many teachers in the capital's public schools (Abu Dhabi) had not taken any such course. More than 51% felt that such workshops were seldom conducted and rarely followed. Gitsaki (Edarabia, 2012) also stated that public school teachers were using nothing but textbook material. In

my study, I felt that knowledge of a variety of activity-based teaching strategies would help teachers to find alternative ways of teaching rather than relying on textbooks.

1.2.5.2   Predominant Teaching Style in the UAE

According to Gaad, Arif and Scott (2006) and Shaw, Badri and Hukul (1995), the style of teaching in the UAE continues to be predominantly teacher centred at both the school and college levels. Within this paradigm, the teacher is an authoritative person and students are passive recipients of information. Examples of more traditional settings include lectures, demonstrations and socratic methods. In these settings, students are expected to accept the information that is provided by the teacher without question (Stofflet, 1994). Traditional teachers seek to transfer thoughts and meanings to the passive students and leave little room for student-initiated questions, independent thought or interaction between students (Vast, 1998).

In the early stages of development, the education system in the UAE suffered from a great deal of trial and error with respect to pedagogies and educational methodologies (Dubai School of Government, 2007). These trial and error procedures adversely affected the development of students' learning and leadership capabilities (Dubai School of Government, 2007).

It has been noted, with concern, that poor-quality instruction exists in some tertiary institution and that, on the whole, teaching methods are based on rote memorisation (Gaad, Arif & Scott, 2006; Shaw, Badri & Hukul, 1995). According to an article in the Khaleej Times (2010), there is very little research in the UAE on teaching practices that can lead to enhanced learning outcomes among students. Innovation on the part of teachers is often viewed as difficult because of the demands of complying with a centralised curriculum and evaluation system that is enforced by administrators and school inspectors. Explanation and discussion are the most common methods reported, with little use of small-group, individualized, experimental, laboratory or role-playing methods. Furthermore, the Gulf News (one of the UAE newspapers) claimed that the current system does not help students to

develop a level of creativity and that the teaching style is based on authoritarian and memory techniques that do not support a flexible economy and a world based on knowledge (Gulf News, 2011).

To overcome these problems, the Ministry of Education has adopted Education 2020, a series of five-year plans, up to the year 2020, designed to introduce advanced education techniques and to improve the innovative skills of teachers. Research indicates that improving the classroom environment has the potential to improve student outcomes (Dorman & Fraser, 2009). It was against within this backdrop, and with the hope that using different teaching strategies, such as games, hands-on activities, puzzles and discovery learning, would fit into Abu Dhabi's new Education 2020, that the challenge of introducing mathematics teaching strategies at the tertiary-level was undertaken.

1.3   Research Questions

The overarching aim of the present study was to examine the effectiveness of using activity-based teaching strategies with adult male students who had failed high school. The following research questions were used to help to address this aim:

1. Is a modified Arabic version of the College and University Classroom Learning Environment Inventory (CUCEI) valid for assessing classroom environment among tertiary students in the UAE?

2. Are the activity-based teaching strategies effective in terms of:
   (a)   the nature of the classroom learning environment; and
   (b)   students' satisfaction?

3. Can qualitative research methods be used to examine how using a range of personally-relevant and concrete activities change the learning environment in ways that are perceived to be beneficial by adults who had experienced failure?

1.4   Context of the Study

The purpose of this study was to examine the effectiveness of using activity-based lessons, which included board games, puzzles, discovery learning and hands-on activities. The research took place at the Higher Colleges of Technology (HCT) (described in Section 1.4.1) in the Work Readiness Program (described in Section 1.4.2). As my study involved the effectiveness of using activity-based teaching strategies with these adult male students, Section 1.4.3 describes what these activities involved.

1.4.1   The Institute

The Higher Colleges of Technology (HCT) is the largest institute of tertiary education in the UAE, comprises 17 campuses located throughout the country, has an enrolment of more than 19,000 students, and employs 2,000 faculty and staff (HCT, 2012). UAE citizens, who meet the admission requirements, are offered the opportunity to study and receive free postsecondary education. Students must be recipients of a high school certificate and must have received passing grades on the national English and mathematics examinations. The UAE Government, in its efforts to provide a skilled labour force for a nation that is still experiencing unprecedented growth, recognises the need for a sound educational system for its citizens. While the current employment ranks are filled mostly by expatriates, a diploma from an institute of higher learning such as HCT is critical for the country's goal of nationalising the workforce (i.e. providing secure jobs, training and development programs for the UAE Nationals in order to increase their qualifications and experience, and to reduce the unemployment rate). Towards this end, HCT offers the Work Readiness Program (WRP) for those students who decide to go back to college to upgrade their qualifications.

1.4.2   Work Readiness Program (WRP)

In my experience, a great number of Emirati adults, of varying ages, have not concluded their formative education. Although some of the students who dropped out

were able to secure employment in government sectors, radical streamlining has resulted in the identification of many employees who are considered to be under-competent or deficient in the skills required to hold down their jobs. As government positions continue to diminish, this has led to an increase in the number of Emiratis who are unemployed because of a lack of qualifications or education.

In response, the Ministry of Presidential Affairs, in partnership with the Centre of Excellence for Applied Research and Training (CERT) and HCT, initiated the Work Readiness Program (WRP). This program aims to assist UAE nationals, who lack the necessary education, professional skills and/or the technical aptitude, to receive the education required to re-enter the work force. The program is accessible to any UAE national who has not finished high school and is unemployed. The program accommodates both men and women. The core subjects of English, mathematics and technology are offered and students are also given the opportunity to learn effective communication, time management and problem solving skills.

At the time of this research, the stability of the program was under threat because of the decreasing number of graduates who found employment at the end of the program. In a bid to address this concern, consideration was given, by those responsible for the WRP, to modifying the methods used to help students to attain the skills that they were lacking.

The WPR consists of three 18-week semesters with 25 periods per week. The WRP curriculum covers English, computer skills, work skills, mathematics and Arabic. As part of the program, the students attend work experience for a period of 6 to 8 weeks in the final semester. All of the men involved in my study were enrolled in the WRP.

1.4.3 Activity-Based Teaching Strategies

In my experience, students often lack enthusiasm when it comes to learning mathematics and this, in turn, can affect their success. The development of the activity-based strategies that were evaluated in my study drew on the results of past studies that suggest games, puzzle worksheets and hands-on activities in mathematics

can improve students' outlook (Bragg, 2007; Massey, Brown & Johnston, 2005). Past research indicates that activity-based strategies that involve playing games and solving problems related to real-life situations have the potential to draw students into the learning process and to reassure them by allowing them to participate in a more collaborative environment (Gosen & Washbush, 2004; Proserpio & Gioia, 2007; Zantow, Knowlton & Sharp, 2005).

Activity-based methods can be used to encourage hands-on discovery, which can enhance the development of valuable learning skills through direct experiences (Tolman, 1999). This method of teaching requires that all students, whatever their age, be active mentally and/or physically during the entire lesson (Rowland & Birkett 1992). During activity-based teaching, the classroom environment is considered to be authentic because it is based on activities that are planned with the students' interests in mind. During the process of activity-based learning, it is important that the teacher respects students by upholding their rights to their feelings, ideas and opinions. An important component of activity-based learning is the need to provide scope for students to inquire and to interact (Hendricks, 1997). Therefore, in my activity-based classrooms, students were positioned as inquirers rather than receptors of facts and procedures. In this respect, activity-based learning aimed to provide students with the opportunity to make significant decisions about their learning (Nayak & Rao, 2002).

It was anticipated that the use of activity-based teaching strategies would have a positive impact when used with adult male students who had experienced failure during their childhood education.

1.5   Theoretical Framework

This study involved a mixed-methods approach in which a quantitative and qualitative data were collected concurrently. Quantitative data were collected using a pre–post design and, during the data collection, analysis and interpretation phases, I worked from a post-positivist paradigm. From this post-positivist paradigm, I was drawn to the idea that researchers can never perform enough research and to be absolutely certain that a theory is proved because there are all sorts of reasons why a

particular study or group of studies might yield false results, such as favouritism, poor instruments, inappropriate subject selection or misinterpretations of the data. From this post-positivist stance, I aimed to determine universal laws that control and determine individuals and social performance. As a post-positivist researcher, I worked on the assumption that all meaningful problems can be framed in precise, unambiguous ways using precise hypotheses and clear methods (Cohen, Manion & Morrison, 2007).

In the post-positivist paradigm, knowledge was considered to be 'hard' and 'tangible', meaning that there is an emphasis on numbers and mathematical models (Cohen, Manion & Morrison, 2007). From this paradigm, I was justified in my emphasis on variables, hypotheses and propositions which are derived from a particular theory that sees the world in terms of causes and effects. The methodology of the post-positivist paradigm is based upon the scientific method, for which causality, cause and effect and controlled experiments are considered standard procedures. Similarly, in this paradigm, data are analysed with strict statistical methods.

One advantage of drawing from this paradigm was that it was considered to be free from the researcher's bias because it highlights the use of methodology and research methods that reduce bias and it is free from prejudices. One of the limitations of using this paradigm alone was that consideration could not be given to individual opinions or causal factors.

By involving the collection of qualitative data, I also drew from the interpretive paradigm, which supports the belief that reality is constructed by subjective perceptions and that predictions cannot be made. Researchers who agree with this paradigm are interested in the social construction of meaning (Babbie & Mouton, 2001). Because people have free will, purposes, goals and intentions, they should be studied as active agents (Littlejohn, 2000).

I was drawn to the interpretive approach because it allowed me to investigate the reactions of the men who were enrolled in my mathematics class in context. When

drawing on the interpretive paradigm, I was able to explore socially-meaningful action through direct detailed observations in natural settings in order to arrive at understanding and interpretations of how these students create and maintain their learning environment (Neuman, 1997). The epistemology of this paradigm is that experiences are unique and individual. It is an approach based on the idea that humans cannot come to know how the world really is, regardless of the research method used. Interpretive researchers propose that generalisable truths and laws about human behaviour be abandoned and, instead, concentrate on local understanding.

The interpretive research paradigm is concerned with the creation of meaning, and is characterized by a concern for the individual and his/her view of reality. Therefore, I drew on this paradigm as I explored students' reactions to and with the activity-based session. The methodology of the interpretive paradigm is based on naturalistic inquiry with participants and observers. In this paradigm, the researcher is the instrument (Willis, 2007). Data tend to be richly descriptive and focus on process, meaning and understanding. This paradigm tends to involve using qualitative research methods such as ethnography and case studies. However, it can also incorporate many quantitative research methods and an inductive mode of inquiry to build abstractions, concepts, hypotheses or theories. Subsequent research findings are in the form of themes, categories, typologies, concepts or tentative hypotheses (Willis, 2007).

1.6   Significance of the Study

This section briefly includes identification of the significance of my study, which is expanded upon in Chapter 5. The results of this study could be of significance to the Ministry of Education as it provides a new conceptualisation of teaching strategies that engage adult students who have experienced difficulties in learning mathematics. The results have the potential to guide the development of a mathematics curriculum for adult students that incorporates the use of activity-based strategies.

The results of this research have the potential to change the way in which teachers teach mathematics to adult males. It is anticipated that the results could encourage teachers to use pedagogical strategies to deliver mathematics concepts in a more interesting manner that involves students in the process of learning. In particular, the results of the research are likely to highlight to teachers the importance of using a range of teaching strategies to assist students who have experienced difficulties in learning mathematics, thus providing students with different approaches to solving mathematical problems.

As discussed previously, the teaching style in the UAE has been predominantly teacher-centred and has involved a didactic, direct approach. Although much work is being undertaken to change this at the school level, none has been undertaken at the college and university level. The results of my study could add weight to the argument that pedagogical changes at this level are worthwhile. Because the students who attended the WRP program have never been exposed to practical mathematics lessons and have traditionally experienced failure in mathematics, the results of this research could have a significant impact on the types of student-centred teaching strategies that are used by mathematics teachers in the future.

From a personal perspective, this research has been of significance in assisting me to develop, understand and apply a range of pedagogical strategies aimed at enhancing motivation, attitudes towards mathematics and perceptions of the learning environment among my students.

This research is significant to the field of learning environments because it is one of the first such studies conducted in the United Arab Emirates. It is also significant that a carefully-modified and translated version of the CUCEI has been validated and made available to educators and researchers in the United Arab Emirates. The study also represents one of the few learning environment studies anywhere in the world that focused on the effectiveness of activity-based teaching strategies in mathematics in terms of the classroom environment perceived by adult male students.

My study adds to the richness of learning environment research with a primary focus on the mathematics classroom (e.g. Chionh & Fraser, 2009; Dorman, 2001; Kilgour, 2006; Majeed, Fraser & Aldridge, 2002; Mink & Fraser, 2005; Moldavan, 2007; Ogbuehi & Fraser, 2007; Spinner & Fraser, 2005). Relatively few past learning environment researches have focused specifically on mathematics classes, and none of these focused on college adult male students who had experienced difficulties in learning mathematics when they attended school.

1.7 Overview of the Thesis

The central aim of this thesis was to examine the effectiveness of using teaching strategies to engage adult male students who had previously experienced childhood difficulties with learning mathematics. The thesis is divided into five chapters.

Chapter 1 has provided background to the study and introduced the reader to the United Arab Emirates and the education system of the United Arab Emirates, including details about primary, secondary and higher education and the Work Readiness Program (WRP). The chapter also included identification of the context of the study, the objectives of the research and the theoretical framework. Finally, the chapter provided an overview of the significance of the study.

Chapter 2 provides a review of literature related to the present study. The early work and history of learning environment research are summarised, beginning in the 1960s with the research of Walberg and Moos (Moos, 1974a; Walberg & Anderson, 1968) in the USA and leading up to the many recent applications of learning environment research around the world (Fraser, 2012). The chapter also includes a description of the development, validity and reliability of eight learning environment questionnaires that have historical and contemporary significance. This chapter also provides a review of literature about adult learning theories, such as constructivism, social constructivism and andragogy, which provide information about the best educational experiences to incorporate into my own intervention.

Chapter 3 is devoted to describing the research methods used in my study to answer the three research questions. Included in this chapter is description of the quantitative and qualitative research methods used. The data sources are described in terms of the role of the participants, the sample used and the population from which the sample was drawn. The chapter also includes consideration of the analysis of both the quantitative and qualitative data in my study. Also, ethical considerations are briefly discussed.

Chapter 4 is devoted to reporting the analyses and results for the quantitative and qualitative data gathered to answer the three research questions in this study. The factor structure and reliability of the instrument are reported to verify whether a modified Arabic version of the College and University Classroom Environment Inventory (CUCEI) is valid for assessing classroom environment among tertiary students and whether the activity-based teaching strategies are effective in terms of the nature of the classroom learning environment and students' satisfaction. Finally, the chapter provides reporting of the use of qualitative information to illuminate whether using activity-based teaching strategies changed the learning environment in ways that were perceived to be beneficial by adults who had experienced failure. In particular, use was made of two vignettes that were interpreted with commentary immediately after, following the approach recommended and used in other studies involving the learning environment (Aldridge, Fraser & Huang, 1999; Aldridge, Fraser & Ntuli, 2009).

Further discussion of my study is provided in Chapter 5. The study and its main findings are summarised. Implications for improving the classroom learning environment in UAE classes are presented and, as well, limitations and suggestions for further study are considered.

Chapter 2

LITERATURE REVIEW

2.1   Introduction

This study involved investigating the effectiveness of teaching strategies that were employed to engage UAE college mathematics adult males' students who experienced difficulties in learning mathematics in the United Arab Emirates. This chapter provides a review of literature relevant to the present study under the following headings:

- Learning Environments (Section 2.2);
- Adult Education (Section 2.3); and
- Chapter Summary (Section 2.4).

2.2   Learning Environments

This section provides elaboration of the history and development of learning environments research (Section 2.2.1); the development, validity and use of learning environment instruments (Section 2.2.2); and the College and University Classroom Environment Inventory (CUCEI, Section 2.2.3), which was chosen for my study.

2.2.1   History and Development of Learning Environment Research

The study of learning environment grew out of the earlier work in social psychology in the USA. In the 1920, researchers such as Hartshorne and May (1928) proposed that behaviour is specific to the situation, which is a central concept in learning environments research. The idea that behaviour is situational is the very reason why contemporary researchers often investigate people within their environment rather than in isolation. Researchers such as Kurt Lewin, Henry Murray, Rudolf Moos, Herbert Walberg and Gary Anderson had different views about the field of learning environment.

Kurt Lewin, an eminent social-psychologist, introduced the idea of human behaviour being a function of both the person and the environment. Later research owes much to Lewin's basic idea about the impact of the environment on the person. Lewin (1936) proposed that behaviour (*B*) is the result of interaction between the person (*P*) and the environment (*E*), and he developed a mathematical formula to express this concept: $B = f(P, E)$.

However, two years later, Murray looked at learning environment from a different angle by emphasising an understanding of personality development. This involved feelings, likes and dislikes and memory, along with idea of environment *press* (Murray, 1938), which also was another concept used in later research.

In the 1950s, Pace and Stern (1958) expanded Lewin's and Murray's earlier ideas and continued the study of behaviour, including the psychological needs of the individual (needs) and their relationship to the environment (press) using a need-press model (Chàvez & Càrdenas, 1980; Dorman, 2002). Pace and Stern (1958) added the concept of perceived climate to earlier ideas, with this significant conceptual development becoming a key concept of learning environment research. Stern (1970) paid attention to the fit between a person and his/her environment as an important addition to the field.

In 1960s, the pioneering foundations to learning environment research in education were laid by Rudolf Moos and Herbert Walberg (Fraser, 1998). Moos's study was concerned with social climate scales and involved a framework of three basic types of dimensions of human environment: Relationship Dimensions, Personal Development Dimensions, and System Change and System Maintenance Dimensions (Moos, 1974a, 1974b). The research involving the three dimensions led to the development of the Classroom Environment Scale (CES) for investigating the perceptions of students and their ideas about their place within the classroom (Moos & Trickett, 1974).

Another questionnaire was developed by Walberg and Anderson (1968) as a part of the research associated with the Harvard Physics Project, and this still influences

instrument development today. This questionnaire, the Learning Environment Inventory (LEI), originally was developed to investigate students' perception of the classroom climate associated with the delivery methods in a physics course for secondary students. Walberg established that students could make valid judgements about their learning environment that were useful in learning environment research (Dorman, 2002). This idea that students' judgements are valid and useful is a central concept in contemporary educational research which enables students' voices to be heard.

Learning environment research then spread from the USA to The Netherlands where it was taken up by Theo Wubbels and colleagues (Wubbels & Brekelmans, 1997, 1998, 2005; Wubbels & Levy, 1993), and to Australia, where it was carried forward by Barry Fraser (Fraser, 1998; Fraser, 2007). Learning environment research has since spread further afield to Asia (Fraser, 2002; Goh & Fraser, 1998; Quek, Wong & Fraser, 2005a, 2005b) and South Africa (Aldridge, Laugksch & Fraser, 2006; Aldridge, Laugksch, Seopa & Fraser, 2006).

One of the most significant contributions of Wubbels and colleagues in The Netherlands was the development of the Questionnaire on Teacher Interaction (QTI; Wubbels, 1993; Wubbels & Levy, 1993; Wubbels et al., 1997) because interpersonal relationships between students and teachers are such an important aspect of the learning environment (Wubbels & Brekelmans, 1998). Using the QTI, Wubbels (1993) found that interpersonal teacher behaviour was associated with student outcomes.

2.2.2   Development of Learning Environment Instruments

A hallmark of the field of learning environment is the accessibility of numerous economical, validated and widely-used questionnaires that have been validated and used for assessing students' perceptions of classroom environment (Fraser, 2002; Wubbels & Brekelmans, 1998). Few fields of education can assert the existence of such a rich range of validated and flexible instruments which have been used in so many research applications (Aldridge & Fraser, 2000). Students are the best judges

about their classroom because they face many different learning environments and have spent sufficient time in their class to draw an accurate conclusion (Fraser, 2001). However, if teachers are inconsistent in their performance, they usually project a reliable image of the long-lasting characteristics of the classroom environment. A distinguishing feature of most of instruments is that they have a form to measure perceptions of actual or experienced classroom environment and a form to measure perceptions of preferred or model classroom environment (Wubbels & Brekelmans, 1998).

The following sections review literature about the development, validity and use of learning environment instruments. The first section reviews some historically significant questionnaires (Section 2.2.2.1), followed by the My Class Inventory (MCI) (Section 2.2.2.2) and the Questionnaire on Teacher Interaction (QTI, Section 2.2.2.3). The next sections consider instruments that focus on particular learning environments such as the Science Laboratory Environment (SLEI, Section 2.2.2.4), Constructivist Learning Environment Survey (CLES, Section 2.2.2.5) and What Is Happening In Class? (WIHIC, Section 2.2.2.6). Finally, the translation of learning environment questionnaires into various languages is considered (Section 2.2.2.7).

2.2.2.1 *Historically Significant Questionnaires: LEI, CES and ICEQ*

This section provides some background on three historically important questionnaires, namely, the Learning Environment Inventory (LEI), Classroom Environment Scale (CES), and Individualized Classroom Environment Questionnaire (ICEQ). Also the College and University Classroom Inventory (CUCEI), which is the instrument that was used in my study, is introduced briefly here. The CUCEI is considered in detail in Section 2.2.3.

As noted previously, Walberg developed the Learning Environment Inventory (LEI) in the late 1960 in the USA to evaluate students' perceptions of their environment during his research and evaluation involving Harvard Project Physics (Walberg & Anderson, 1968). The Classroom Environment Scale (CES) was also developed in the USA in the late 1960s, and it developed out of Moos' categorisation of human

environment dimensions into three areas: Relationship Dimensions, Personal Development Dimensions and System Maintenance and Change Dimensions. The creation of the CES permitted researchers to study the learning environment according to these three dimensions as they relate specifically to schools (Moos, 1974a, 1974b).

Walberg's (1968) Learning Inventory (LEI) and Moos and Trickett's (1974) Classroom Environment Scale (CES) have been translated into other languages as research developed worldwide. The LEI was validated in India in Hindi with 166 groups of students in 83 general science classes and 134 similar groups in 67 social studies classes (Walberg, Singh & Rasher, 1977). Paige (1979) investigated associations between elementary students' attitudes and the scales of the CES and LEI in Indonesia. The reliability and validity of both the CES and LEI were demonstrated.

The Individualized Classroom Environment Questionnaire (ICEQ) was initially developed by Rentoul and Fraser (1979) for the purpose of distinguishing individual classrooms from conventional ones. The way in which the questionnaire was shaped was guided by the literature on individualized and inquiry-based learning. The final version contains 50 items which are equally divided among the five scales.

The validity and reliability of the ICEQ were established in several settings in several countries (Fraser, 1990). An initial study, which was conducted in Sydney, Australia by Rentoul and Fraser (1979), involved 225 junior high students in 15 classes. Wierstra (1984) analysed data from 398 students who were 15−16 years old and in nine classes in Netherlands. In Tasmania, the questionnaire was further validated by Fraser, Nash and Fisher (1983) with students in 116 grade eight and nine science classes.

Until the 1980s, little work had been undertaken on learning environments in universities and colleges that is parallel with the work in primary and secondary schools. For this reason, Barry Fraser and David Treagust thought of developing the College and University Classroom Inventory (CUCEI) to be used in small classes of

around 30 university students, which often are referred to as seminars or tutorials (Fraser & Treagust, 1986; Fraser et al., 1986). The questionnaire consists of seven scales with each scale containing seven items. Fraser, Williamson and Tobin validated the CUCEI in Australia with 536 alternative high-school students in 45 classes and 106 teachers.

At Queensland University of Technology, Yarrow, Millwater and Fraser (1997) conducted an action research study with preservice teachers and their elementary school students to evaluate perceptions of their classroom learning environment. The CUCEI was administered to 536 adult students from 45 classes who decided to come back to school to complete their education. The result from the study indicated that these students perceived their classes as having more involvement, satisfaction, innovation and individualization than a control group.

A similar type of study was carried out in Australia by Fraser, Williamson and Tobin (1987) who evaluated a specific type of alternative high school that is called 'Senior College' and accommodates adult learners who were returning to complete their education. When the CUCEI was administered in 45 classes which involved 536 students, alternative high school students reported more involvement, satisfaction, innovation, and individualisation compared to a control group. Because the CUCEI was used in my study, it is considered in more detail in Section 2.2.3.

2.2.2.2 My Class Inventory (MCI)

Fisher and Fraser (1981) developed the My Class Inventory (MCI) especially for younger students as a simplified form of the LEI. The questionnaire was initially written for children aged 8−12 years and it has also been used successfully with students in the middle school (Goh & Fraser, 2000; Majeed, Fraser & Aldridge, 2002). In 1985, Fraser and O'Brien focused on student and teacher perceptions of classroom environment and diverged from previous studies of elementary classrooms which involved either systematic observation or naturalistic inquiry and case study. Their final short form of the MCI was administered in eight schools in Sydney, Australia which involved 758 grade 3 students in 32 classes. The short form revealed

good discriminant validity and alpha reliability coefficients for both actual and preferred forms (Fraser & O'Brien, 1985**).**

The MCI is different from the LEI in four ways. First, fatigue was reduced for younger students because the MCI contained only five of the LEI's original 15 scales. Second, in order to improve the reliability, the wording has been simplified. Third, the four-point format response was changed to a Yes/No format and, fourth, the separate scoring sheet was eliminated so that students could circle responses directly on the questionnaire itself.

In Singapore, Goh and Fraser (2000) conducted a study among 1512 elementary mathematics students. A convenient and widely-applicable version of the MCI for assessing students' perceptions of their classroom climate was validated.

Although the MCI questionnaire was meant for use with younger students, Majeed, Fraser and Aldridge (2002) used it in research with lower secondary mathematics students in Brunei Darussalam. The study took place in 15 government secondary schools in 81 classes where 1565 students answered the questions. The data analysis revealed that the factor structure, reliability and discriminant validity all were satisfactory. The findings are noteworthy because the use of factor analysis had not been reported for the MCI in previous studies in other countries.

The MCI was also used in the USA. According to a study that was conducted by Mink and Fraser (2005), in Florida, with 120 students from grade 5, the MCI scales exhibited satisfactory internal consistency reliability and discriminant validity. Previous research was replicated in that students' satisfaction was higher in classrooms with a more positive learning environment. The reliability and factorial validity of the MCI−short version was also examined by Sink and Spencer (2005) in Washington State in a study that involved more than 2800 upper-elementary students. In addition, a revised version of the MCI−SF consisting of 18 items was found to be valid. In a study that took place in Texas with 588 students in grades 3−5, the MCI was cross-validated and used to evaluate the effectiveness of educational alternatives in science (Scott Houston, Fraser & Ledbetter, 2008).

2.2.2.3   Questionnaire on Teacher Interaction (QTI)

The purpose of this questionnaire is to carry out investigations about the interpersonal relationships between teachers and their students, what preferences students have about their relationships with their teachers, and how teachers would like to behave towards their students (Wubbels & Brekelmans, 1998, 2012; Wubbels & Levy, 1993).

The QTI was developed to assess student perceptions of the eight behaviour aspects. The questionnaire has 48 items, six for every sector. The items are arranged in cyclic order and in blocks of four. Items 1 to 24 assess the four scales of Leadership behaviour, Understanding behaviour, Uncertain behaviour, and Admonishing behaviour. Items 25 to 48 assess the scales of Helpful/Friendly behaviour, Student responsibility and freedom behaviour, Dissatisfied behaviour, and Strict behaviour. The frequency response alternatives used are Never …..Always. The total score for a particular scale is simply the sum of the circled numbers for the six items belonging to that scale. Omitted or invalid responses are score 3. For example, the Leadership behaviour scale total is obtained by adding the scores given to Items 1, 5, 9, 13, 17 and 21.

Research with the QTI has been completed at various grade levels in the USA (Wubbels & Levy, 1993) and Australia (Fisher, Henderson & Fraser, 1995). Goh pioneered the use of the QTI in a simplified form in Singapore with a sample of 1,512 elementary-school students in 13 schools (Goh & Fraser, 1996, 1998, 2000). This study cross-validated the QTI for use in a different country and found it to be useful in several research applications.

Scott and Fisher (2004) translated the QTI into Standard Malay and cross-validated it with 3,104 elementary science students in 136 classes in Brunei Darussalam. An English version of the QTI was cross-validated for secondary schools in Brunei Darussalam for samples of 1188 science students (Khine & Fisher, 2002) and 644 chemistry students (Riah & Fraser, 1998).

In Korea, Kim, Fisher, and Fraser (2000) validated a Korean-language version of the QTI among 543 grade 8 students in 12 schools, and Lee, Fraser and Fisher (2003) provided further cross-validation information for the QTI with a sample of 440 grade 10 and 11 science students. In Indonesia, Fraser, Aldridge, and Soerjaningsih (2010) translated the QTI into Indonesian language and cross-validated it with a sample of 422 university students in 12 classes.

Fisher, Fraser, and Rickards (1997) conducted a study with a sample of 3,994 high school science and mathematics students which revealed that the Cronbach alpha reliability ranged from 0.63 to 0.88 for different QTI scales at the student level of analysis. The questionnaire was also validated in Turkey when a study was conducted by Telli, den Brok and Cakiroglu (2007) with a sample of 674 grade 9−11 students in 24 classes.

2.2.2.4 Science Laboratory Environment Inventory (SLEI)

The SLEI was developed to assess students' views of laboratory classroom settings, investigate the impact of laboratory classes on students' achievement and attitudes, give teachers a straightforward method to conveniently assess and improve the climates of their classrooms, and determine the impact of a new curriculum or teaching method on classroom environment (Fraser, Giddings & McRobbie, 1992, 1995).

The SLEI consist of five different scales and has 35 items altogether. The scales are Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment. The questionnaire can be used to pinpoint differences between the perceptions of students of the actual classroom environment and that preferred by students (Fraser, Giddings & McRobbie, 1991). The instrument is intended for use at the high school (upper secondary) and higher education levels.

The SLEI was validated with a sample of 5447 students from 269 senior high school and university classes in six countries. Fraser and McRobbie (1995) cross-validated

the instrument with a sample of 1594 senior high school students in 92 classes in Australia.

In Tasmania, Australia, the SLEI questionnaire was used together with the QTI in a study about associations between students' perceptions of their biology teachers' interpersonal behaviour and their laboratory learning environment. Eight schools contributed to the study which included a sample of 489 students from 28 senior-high biology classes. Henderson, Fisher and Fraser (2000) reported that the validity and reliability of both questionnaires were good.

In Miami, Florida, another study was undertaken to evaluate the use of anthropometric activities in terms of student outcomes and classroom environment (SLEI). This study took place in a suburban public high school (Lightburn & Fraser, 2007) and involved 761 biology students in 25 classes. Data analysis supported the internal consistency reliability and factorial validity of the SLEI.

In Korea, the SLEI was translated in to a Korean language. A total of 439 senior high school students were involved in validating the instrument: 145 humanities stream students, 195 science-oriented stream students, and 99 science-independent students. Fraser and Lee (2009) established the internal consistency reliability and factorial validity of the SLEI's Korean version.

In 1997, Newby and Fisher developed the Computer Laboratory Environment Inventory (CLEI) which was based on the SLEI questionnaire. The purpose of this questionnaire was to measure student perceptions with regards to their laboratory environment: Student Cohesiveness, Open-Endedness, Integration, Technology Adequacy and Laboratory Availability. The CLEI was demonstrated to be a valid and reliable instrument.

In Singapore, two studies took place in secondary-school chemistry classes with the Chemistry Laboratory Environment Inventory (CLEI), which is a modified version of the SLEI. In co-educational government schools, 1,592 students contributed in the first study, while the 497 students were involved in the second study involving gifted

and non-gifted students in independent schools. Strong support was provided by both studies for the validity of the CLEI when it was used with students in Singapore (Quek, Wong & Fraser, 2005a, 2005b; Wong & Fraser, 1996).

2.2.2.5 Constructivist Learning Environment Survey (CLES)

The CLES was developed for evaluating the impact of an innovative teacher development program in school classrooms. It was also developed with a psychological view of learning that focused on students as co-constructors of their own knowledge (Taylor, Dawson & Fraser 1995; Taylor & Fraser, 1991; Taylor, Fraser & Fisher, 1997). Another feature of the CLES is that it has the ability to characterize specific dimensions of the constructivist classroom. The CLES has been validated in Western Australia by Taylor et al. (1997) with a sample of 494 13-year-old students in 41 science classes around 13 schools.

In Taiwan and Australia, the CLES was validated in English and Chinese versions. In Australia, 1081 high school students in 50 classes participated in the study and, in Taiwan, 1879 students from 50 classes participated. Aldridge et al. (2000) reported that the data analyses supported each scale's internal consistency reliability, factor structure and ability to differentiate between classrooms.

In South Africa, Aldridge, Fraser and Sebela (2004) administered the CLES in the IsiZulu language to 1864 mathematics students in 43 classes. The purpose of this study was to support teachers in South Africa to become more reflective in teaching mathematics. The questionnaire was administered twice in a period of 12 weeks, once at the beginning of the study and again at the end of an intervention phase that focused on promoting a constructivist orientation in the classroom learning environment.

Peiro and Fraser (2008) undertook a study in the USA that used a modified English and Spanish version of the CLES along with an attitudinal survey instrument. A sample of 739 students in grade K−3 in Miami, Florida participated in this study. The results supported the factor structure and internal consistency reliability of the CLES.

The relationship between the science classroom environment and students' attitudes towards science was positive.

In another study in Florida, Tulloch (2011) used the CLES with a sample of 544 two-year college students to investigate age, gender and ethnicity as determinants of classroom environment, in addition to the effect of classroom environment on students' attitudes. Data analyses in the community college setting supported the CLES's factorial validity, internal consistency reliability, and ability to differentiate between classrooms.

In north Texas, a new version of the CLES, the CLES−CS (comparative students), was developed to assess the effect of an innovative teacher development program based on the Integrated Science Learning Environment (ISLE) model. A sample of 1,079 students participated in the study in 59 classrooms. It was reported that the new version was valid and useful in Texas because the factor structure, internal consistency reliability, discriminant validity and ability to differentiate between classrooms were supported (Nix, Fraser & Ledbetter, 2005).

2.2.2.6 What Is Happening In this Class? (WIHIC)

The WIHIC questionnaire is the classroom environment instrument that is most frequently used around the world. According to Dorman (2008, p. 181), "the WIHIC has achieved almost bandwagon status in the assessment of classroom environments". The WIHIC brings parsimony to the field of learning environment by combining modified versions of the most salient scales from a wide variety of existing questionnaires with additional scales that assess contemporary educational concerns. The WIHIC consists of two forms, namely, a separate Class form which assesses a student's perceptions of the class as a whole and Personal form which assesses a student's personal perceptions of his or her role in a classroom.

The WIHIC, which was developed by Fraser, Fisher and McRobbie (1996), originally consisted of a 90-item nine-scale version which was refined by the statistical analysis of data from 355 junior high-school science students, together

with the extensive interviewing of students about their opinions of their classroom environments in general, the wording and salience of individual items and their questionnaire responses. Seven scales which involved 54 items survived these procedures. Later, in Australia and Taiwan, the 54 items were expanded to 80 items in eight scales for the field testing of the second version of the WIHIC with junior high-school science classes.

Aldridge, Fraser and Huang (1999) developed the final form of the WIHIC which contains seven eight-item scales. This was finalised after the questionnaire was administered to an Australian sample of 1,081 students in 50 classes who responded to the original English version and a Taiwanese sample of 1,879 students in 50 classes who responded to a Chinese version that had undergone careful procedures of translation and back translation. Aldridge and Fraser (2000) stated that, for both the Australian and Taiwanese samples, the factorial validity and internal consistency reliability were strong and each scale was capable of differentiating significantly between the perceptions of students in different classrooms.

In 2003, Dorman produced a comprehensive and impressive validation when the WIHIC was administered to a cross-national sample of 3,980 high-school students from Australia, the UK and Canada. Because a confirmatory factor analysis yielded satisfactory fit statistics, it supported the seven-scale a priori structure and demonstrated a good fit between the model and the data.

The WIHIC has been validated in several states of the US, namely, California with 665 middle-school science students (den Brok, Fisher, Rickards & Bull, 2006), New York with 1434 middle-school science students (Wolf & Fraser 2008) and Miami with 520 elementary science students (Allen & Fraser 2007), and in several countries, namely, Australia with samples of junior high school science students consisting of 1081 student (Aldridge et al., 1999) and 567 students (Fraser, Aldridge & Adolphe, 2010), Singapore with 2310 grade 10 geography and mathematics students (Chionh & Fraser, 2009) and 250 working adults attending computer application courses (Khoo & Fraser, 2008), Canada and Australia with 1404 students in technology-rich classrooms (Zandvliet & Fraser, 2004, 2005), Jammu, India

among 1021 middle-school science students (Koul & Fisher, 2005), and Australia, the UK and Canada with 3980 high-school students (Dorman 2003).

Furthermore, the WIHIC instrument has been translated into numerous languages with different samples in various countries, including the Arabic language among 763 female college students in the UAE (MacLeod & Fraser, 2010), the Chinese language among 1879 junior high school science students in Taiwan (Aldridge et al., 1999), the IsiZulu language among 1077 primary school students in South Africa (Aldridge, Fraser & Ntuli, 2009), the Indonesian language among 594 junior high school science students (Fraser, Aldridge & Adolphe, 2010), and the Korean language among 543 secondary science students (Kim, Fisher & Fraser, 2000).

2.2.2.7 Translating Learning Environment Questionnaires into Various Languages

Studies have shown robust ties between learning environment variables and students' cognitive and affective learning outcomes (den Brok, Brekelmans & Wubbels, 2004; Fraser, Aldridge & Adolphe, 2010). Using instruments unaltered in different countries is almost impossible because of the constraints on spoken language are cultural and social differences. In this respect, MacLeod and Fraser (2010) indicated that translations of validated learning environment questionnaires have provided valuable tools for researchers in many countries. Table 2.1 provides a summary of the numerous learning environment questionnaires that have been translated into 12 other languages.

From Table 2.1, it can be seen that the WIHIC has been translated into five languages, namely, Chinese, Creole, Indonesian, Korean and Spanish. The CLES has been translated into the four languages of Chinese, Korean, Taiwanese and Thai. The LEI has been translated into Hebrew, Hindi and Indonesian.

Table 2.1   Summary of the Translation of Classroom Learning Environment Questionnaires into Various Languages

Language	Questionnaire	Authors
Chinese	What Is Happening In this Class? (WIHIC)	Aldridge et al. (1999)
		Aldridge & Fraser (2000) Yang et al. (2002)
	Chinese Language Classroom Environment Inventory (CLCEI)	Chua et al. (2000, 2001)
	Constructivist Learning Environment Survey (CLES)	Aldridge et al. (2000)
Creole	What Is Happening In this Class? (WIHIC)	Allen (2003)
Hebrew	Learning Environment Inventory (LEI)	Hofstein et al. (1979, 1980) Hofstein & Lazarowitz (1986)
	Science Laboratory Environment Inventory (SLEI)	Hofstein et al. (1996, 2001)
Hindi	Learning Environment Inventory (LEI)	Walberg et al. (1977)
Turkish	Questionnaire on Teacher Interaction (QTI)	Telli et al. (2007)
Indonesian	Classroom Environment Scales (CES)	Paige (1979)
	Learning Environnent Inventory (LEI)	Paige (1979)
	Questionnaire on Teacher Interaction (QTI)	Fraser, Aldridge, & Adolphe, (2010) Fraser, Aldridge & Soerjaningsih. (2010)
	What Is Happening In this Class (WIHIC)?	Margianti et al. (2004)
Japanese	Classroom Environment Scale (CES)	Hirata & Sako (1998)
Korean	Constructivist Learning Environment Survey (CLES)	Kim et al. (1999)
		Lee & Taylor (2001)
	Science Laboratory Environment Inventory (SLEI)	Kim & Kim (1995, 1996) Kim & Lee (1997) Fraser & Lee (2009)
	What Is Happening In this Class? (WIHIC)	Kim et al. (2000)
	Questionnaire on Teacher Interaction (QTI)	Kim et al. (2000)
		Lee et al. (2003)
Malay	Questionnaire on Teacher Interaction (QTI)	Scott & Fisher (2004)
South Africa	Outcomes-Based Learning Environnent Questionnaire (OBLEQ)	Aldridge, Laugksch, Seopa & Fraser (2006).
Spanish	What Is Happening In this Class (WIHIC)	Allen (2003), Peiro & Fraser (2008), Soto-Rodriguez &Fraser (2004)
Thai	Constructivist Learning Environment Survey (CLES)	Wanpen & Fisher (2006)
	Science Laboratory Environment Inventory (CLES)	Puacharearn (2004)
	Questionnaire on Teacher Interaction (QTI)	Kijkosol & Fisher (2006)

Adapted from Macleod & Fraser (2010)

The QTI has been translated into numerous languages including, Turkish, Indonesian, Korean and Malay. In addition, the SLEI is available in Hebrew and Korean, the CES is available in Indonesian and Japanese, and both the Outcomes-Based Learning Environment Questionnaire (OBLEQ) and School-Level Environment Questionnaire (SLEQ) are available in North Sotho or Sepedi (spoken in South Africa; see Table 2.1)

2.2.3   College and University Classroom Inventory (CUCEI)

Because the College and University Classroom Inventory was the learning environment instrument selected for use in my study, it is considered in detail in this section. In my research, classroom environment and Satisfaction were assessed with a modified Arabic version of the CUCEI.

This section is divided into four subsections. The first involves the rationale for selecting the CUCEI for this study (2.2.3.1). The following section (2.2.3.2) offers the reader an overview of the CUCEI, noting that it went through several phases of field testing and refinement (Fraser, Treagust & Dennis, 1986) and has demonstrated its validity and reliability in a number of studies. Section 2.2.3.3 focuses on the dimension assessed by each scale of the CUCEI. Then section 2.2.3.5 involves studies that have validated the CUCEI, as well as a number of its prominent applications in several countries (2.2.3.5). The final section provides a review of research involving the CUCEI in numerous countries (2.2.3.5).

2.2.3.1   Selection of the CUCEI

The CUCEI was chosen for my study because of its suitability for assessing perceptions of classroom psychosocial environment in the Higher Colleges of Technology (HCT) mathematics classroom among adult students in Abu Dhabi. The CUCEI can be used in tertiary education in several lines of research analogous to those previously completed successfully in schools, as well as in a variety of practical applications aimed at improving teaching and learning in higher education (Fraser, Treagust & Dennis, 1986). In addition, I chose to use this particular

instrument because of its suitability for use in small higher education classrooms of about 30 students. This unique feature of this questionnaire and its design allowed me to measure both pretest and posttest perceptions of learning environment for my students as a basis for evaluating the effectiveness of the use of the activity-based teaching strategies. Although all CUCEI scales were initially included in my study, a small number of scales were removed during the validation process described later in Section 4.3.

2.2.3.2   Initial Development of the CUCEI

As mentioned earlier, the CUCEI was designed specifically for the higher education level (Fraser & Treagust, 1986; Fraser, Treagust & Dennis, 1986). The initial development of the instrument was guided by four criteria: consistency with secondary school instruments; coverage of Moos's general categories (Moos, 1974a, 1974b); salience to tertiary teachers and students; and economy. The three general categories are Relationship Dimensions, Personal Development Dimensions, and System Maintenance and System Change Dimensions.

The Relationship Dimension assesses the nature and intensity of personal relationships; examples of these dimensions include students' involvement and cohesiveness with other students (Moos, 1979, p. 14). The Personal Development Dimension assesses the basic directions along which personal growth and self-enhancement occur in a particular environment (Moos, 1976, p. 331). Examples of this are task orientation and competition. The System Maintenance and System Change Dimension assesses the extent to which the environment is orderly, has clear expectations, maintains control and responds to change (Moos, 1979, p. 16). Examples of this are orderliness, organization and innovation.

It was found by Fraser and colleagues (1986) that these criteria could be satisfied with an instrument containing the following seven scales: Personalisation, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation and Individualisation. By writing new items and rewriting existing ones, scales selected from secondary school inventories were refined and modified to make them well-

suited to tertiary seminars and tutorials. These procedures led to a version of the CUCEI which contained seven items per scale as explained below.

2.2.3.3 Description of the CUCEI

The final version of the CUCEI measures seven dimensions of the classroom environment: Personalisation (emphasis on opportunities for individual students to interact with the instructor and on concern for students' personal welfare), Involvement (extent to which students participate actively and attentively in class discussions and activities), Student Cohesiveness (extent to which students know, help and are friendly towards each other), Task Orientation (extent to which class activities are clear and well organized), Innovation (extent to which the instructor plans new, unusual class activities, teaching techniques and assignments), and Individualisation (extent to which students are allowed to make decisions and are treated differentially according to ability, interest or rate of working). Each item of the CUCEI is responded to on a five-point Likert scale with the alternatives of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. The scoring direction is reversed for approximately half of the items as shown in Table 2.2 which elucidates the meaning of each CUCEI scale by providing its classification according to Moos's scheme, a scale explanation, and a sample item.

My students filled in the pretest questionnaire at the beginning of the semester before the activity-based teaching strategies were implemented in the classroom. Later, once the students were familiar with the new teaching strategies, the posttest was given to assess how students perceived their new classroom learning environment. The wording of the items were the same in the pretest and posttest.

Table 2.2 Scale Description and Sample Item for each Scale of CUCEI

Scale	Description/Moos Category	Item
Personalisation	Emphasis on opportunities for individual students to interact with the instructor and on concern for students' personal welfare. (R)	The instructor helps each students who is having difficulty with the work **(+)**
Involvement	Extent to which students participate actively and attentively in class discussions and activities. (R)	There are opportunities for students to express opinions in this class. **(+)**
Student Cohesiveness	Extent to which students know, help and are friendly towards each other. (R)	Students in this class get to know each other well. **(+)**
Satisfaction	Extent of enjoyment of classes. (R)	This class is a waste of time. **(-)**
Task orientation	Extent to which class activities are clear and well organised. (P)	Getting a certain amount of work done is important in this class. **(+)**
Innovation	Extent to which the instructor plans new, unusual class activities, teaching strategies, and projects. (S)	New and different ways of teaching are hardly used in this class. **(-)**
Individualisation	Extent to which students are allowed to make decisions and are treated differently according to ability, interest and rate of working. (S)	Students are generally allowed to work at their own pace. **(+)**

R: Relationship Dimension, P: Personal Development Dimension, S: System Maintenance and System Change Dimension.

Items designated (+) are scored 5, 4, 3, 2 and 1, respectively, for the responses Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. Items designated (-) are scored in the reverse manner.

2.2.3.4   Validation and Application of CUCEI

This section provides comprehensive validation information about the internal consistency reliability and discriminant validity of the actual and preferred forms of the CUCEI which was field tested in Australian and American classrooms. In addition, extensive interviewing and observation of students about their views of their classroom environment were used to refine the preliminary version of the CUCEI (Fraser, Treagust & Dennis, 1986).

The preliminary version of the CUCEI contained 12 items per scale. For validation purposes, in Perth, Western Australia, the actual and preferred forms were field tested with a sample of 127 undergraduate and postgraduate students in 10 classes following several different courses at one multi-purpose tertiary institution. Item analysis was used to pinpoint items whose removal would improve each scale's internal consistency (the extent to which items in the same scale measure the same dimension) and discriminant validity (the extent to which a scale measures a unique dimension not covered by the other scales in the instrument). It was found that the internal consistency of a scale could be improved by removing items with low item−remainder correlations (i.e. correlations between an item and the rest of the scale excluding that item).

A review of past research involving the validation and use of the CUCEI is organised below according to the country where it was conducted. It starts by describing research conducted cross-nationally. Following that, examples of studies from Australia, Singapore, Pacific Islands, Spain, the Netherlands, USA, Malaysia, Thailand and New Zealand are reviewed.

2.2.3.5   Research Involving CUCEI in Numerous Countries

Because the improvement in scale statistics gained through application of item analysis techniques can be lost in subsequent administrations of an instrument because of sampling variations, it is important to cross-validate the refined forms of

instruments to check that reliability and other indices hold up (Fraser, Treagust & Dennis, 1986).

The cross-validation of the CUCEI involved three samples, namely, a large sample of Australian students, a sample of American students and a group of instructors. The Australian sample was selected from undergraduate and postgraduate classes in a variety of disciplines including education, biology, mathematics, communications and psychology. In addition, the discriminant validity was enhanced by removing any item whose correlation with its priori assigned scale was lower than its correlation with any of the other six scales in the CUCEI (Fraser, Treagust & Dennis, 1986).

As mentioned in the previous section, the final form of the CUCEI contains 7 scales with 7 items. The study took place in Perth, Western Australia in two multi-purpose higher education institutions with a sample of 307 students in 30 classes. The American sample involved 65 postgraduate and undergraduate students studying in four education classes in a university in Chicago, USA. The group of instructors comprised of a subsample of 20 of the 30 teachers (16 Australian and 4 American) teaching all of these classes.

The cross-validation data reported for the three mentioned samples was important because it provided additional support for the validity of the CUCEI with Australian students as well as with American students, and it supported the cross-cultural validity of the instrument for use in the USA and when used to evaluate instructors' perceptions. The internal consistency reliability was calculated using Cronbach's alpha coefficient and discriminant validity was also reported. Also, ability to differentiate between classes was investigated by conducting a one-way ANOVA, with class membership as the main effect and using the individual as the unit of analysis, for each CUCEI scale.

Australia

In Australia, Yarrow, Millwater and Fraser (1997) examined the validity of the CUCEI for assessing preservice primary teachers' perceptions of their university classroom environment. The study involved 117 preservice primary teachers in six separate classes undertaking the Bachelor of Education course at Queensland University of Technology. In week 3, the CUCEI was administered to obtain perceptions of actual and preferred classroom environment and it was re-administered in week 13 to gauge any changes in the actual classroom environment. The results were generated by calculating, for each scale of the CUCEI and for each of the six university classes, the mean score for preservice teachers' preferred environment scores and their actual classroom environment towards the beginning of the semester, as well as the actual scores towards the end of the semester. Moreover, for each CUCEI dimension, tests of the significance of differences between correlated means were carried out to examine changes in the actual classroom environment during the semester. Also investigated was the statistical significance of the discrepancy between the preferred environment and the actual environment as perceived by preservice teachers early and late in the semester. The resultant data provided valuable insights about the success of teachers using the learning environment questionnaire to guide improvement in their teaching.

In 1999, Nair and Fisher modified the CUCEI by replacing the Involvement and Satisfaction scales with two new ones, namely, Cooperation and Equity. The researchers included the Cooperation scale because it measures the extent to which students cooperate rather than compete with one another while learning concepts. The Equity scale was included to permit investigation of gender differences in students' perceptions of the learning environment. Also the response alternatives of Strongly Agree, Agree, Disagree and Strongly Disagree were changed to a five-point frequency rating scale of Almost Never, Seldom, Sometimes, Often and Almost Always. Item responses were scored 1, 2, 3, 4 and 5, with the scoring direction reversed for some items. Furthermore, whereas items in the original version were listed in a cyclic manner, all items relating to one scale were grouped together in blocks in the modified version.

Nair and Fisher (1999, 2000) used the modified version in a study of senior secondary and tertiary students studying science. The sample involved 504 students and 24 of their instructors. Principal components factor analysis with varimax rotation indicated that the CUCEI maintained distinctions between the seven dimensions of the instrument, while the Cronbach alpha reliability figures indicated satisfactory internal consistency. It was therefore considered an appropriate instrument for gathering students' perceptions about their computing learning environment.

Booth (1997) used the CUCEI in a study to evaluate the effectiveness of changing formal lectures to increase student–teacher interactions in the learning environment. The project was conducted with a class of 30 final-year dental students at the University of Western Australia's School of Oral Health Science. CUCEI scores revealed improvements in the students' ratings of all scales over the period during which the teaching style was changed. Therefore, the CUCEI appeared to be useful for evaluating changes in teaching methods.

Singapore

An English version of the CUCEI was cross-validated in Singapore by Khine and Goh (2001) with a total sample of 355 teacher education students consisting of 151 primary graduate teacher trainees from the Postgraduate Diploma in Education Program (Primary) and 184 secondary graduate teacher trainees from Postgraduate in Education Program (Secondary). The graduate teacher trainees were actually being trained to teach in different school contexts as primary and secondary school teachers, respectively. The study was conducted to provide validation for the CUCEI when used in the Singapore context, to investigate associations between graduate teacher trainees' attitudes to the course and their perceptions of the classroom environment as assessed by the CUCEI, and to investigate gender-related differences in graduate teacher trainees' perceptions of their learning environments.

The results were statistically significant and supported the cross-cultural validity of the CUCEI scales. Each scale in the questionnaire was found to display satisfactory

internal consistency. Simple correlations between each scale of the CUCEI and the attitudinal measures were calculated to describe associations between environment and attitudinal outcomes. The questionnaire yielded satisfactory validity results when used to assess the learning environment in a tertiary institution in Singapore and established links between environments and attitudes.

Pacific Islands

Coll, Taylor and Fisher (2002) used the CUCEI along with the QTI with a sample of 257 first-year and second-year science students at a regional university in the Pacific Islands, where students were of 12 ethnicities. The data revealed that the QTI exhibited good reliability for all scales, whereas the CUCEI demonstrated satisfactory reliability for only two scales. This could be because of the simple nature of the questions on the QTI, whereas the questions on the CUCEI required more elucidation because English was a second or third language for most participants.

Spain

The (CUCEI) was modified and validated for the educational environment in Spain. Marcelo (1988) conducted a study at the University of Seville with a sample of 200 students in six fields of study. The results revealed acceptable validation statistics for all scales except Involvement. The questionnaire differentiated between the fields of the study for six of the seven scales.

Another study was conducted in Spain by Phan (2008) to test a structural model linking classroom environment, achievement goals, and reflective thinking practice. The sample involved 298 students, 142 of whom were boys and 156 were girls. The students were from different secondary schools in the Republic of Fiji Islands.

The CUCEI was one of the inventories that was administered to students in intact classes together with the Reflective Thinking Inventory Questionnaire (RTIQ) and Achievement Goals Inventories (Phan, 2008). The researcher chose to use four of the seven scales of the CUCEI: Involvement, Satisfaction, Task Orientation and Student

Cohesiveness. The other scales were omitted as the researcher did not think that they reflected salient characteristics of the class environment. The results revealed that the CUCEI was a useful instrument for exploring various classroom components and their influences on achievement goal orientation and academic performance.

The Netherlands

Olani, Hoekstra, Harskamp and Van der Werf (2011) undertook a study of the degree to which students' statistical reasoning abilities, statistics self-efficacy, and perceived value of statistics improved during a reform-based introductory statistics courses. The study also examined whether the changes in these learning outcomes differed with respect to the students' mathematics background and perceived teacher support.

A sample of 96 first-year university students was assessed at the beginning and at the end of the year. Although no prior validity data were available for the scale of Teacher Support, a subscale of the instrument was used in this study because it had been found to relate significantly to many cognitive and affective outcomes in past research (Fraser et al., 1986). It was observed that a large positive change in statistics self-efficacy occurred for students with favourable perceptions of Teacher Support.

USA

In 2009, Goyak validated the CUCEI with a sample of 127 preservice teachers at Midwest College in the USA attending a Foundations of Education class and an Instructional Techniques class. The purpose of the study was to evaluate the effect of using cooperative learning techniques and critical thinking skills on the learning environment perceived by preservice teachers. The CUCEI was administered to answer the first research question about the effect of cooperative learning techniques, while another instrument, the Watson–Glaser Critical Thinking Appraisal, Form–S (WGCTA–FS), was used to measure the critical skills of the preservice teachers.

The study revealed significantly higher means for the cooperative learning group for four of the eight constructs within the CUCEI. The researcher found the CUCEI

ideal for comparing the learning environments of classes taught with traditional lecture and cooperative learning strategies. Goyak found that the CUCEI was both a valid and reliable survey tool and was relevant to students' academic achievement and associated learning outcomes. It also was useful in shaping the learning environment, supporting Fraser's (1993) claim that the CUCEI can help educators in conceptualizing and assessing students' perceptions of social and psychosocial elements of their learning environment.

Malaysia

The CUCEI was validated in a study of the learning environment and language proficiency in Tunku Abdul Rahman University in Malaysia (Thangiah, 2005). The sample consisted of 320 first-year students enrolled in the faculty of accounting and management at a local private institution of higher learning. The researcher administered the questionnaire two weeks before the final examination.

Task Orientation and Individualization were the two CUCEI scales that were related to students' English language grade. English language plays a crucial role in classroom interaction as it is the medium of instruction in this private university. It was discovered that the functioning range of items in the CUCEI was rather limited and should be improved based on the psychometric properties of the instrument revealed through Rasch model analysis. Two unsuitable items were detected that contained negative wording, which led to student confusion while reading the question as they have limited English language proficiency. Secondly, the presence of a gap in item distribution highlighted the point at which a scale is not clear for this group of students, thus decreasing the usefulness of the instrument. It was suggested that new items were essential for the scale to provide more effective measurement.

Thailand

Charik and Fisher (2008) evaluated computer classroom learning environments and students' attitude toward computer courses in a tertiary institution in Thailand. The version of the CUCEI developed by Nair and Fisher (1999) was used along with two

other questionnaires, the Computer Classroom Environment Inventory (CCEI) and the Attitude towards Computers and Computer Courses (ACCC) developed by Newby and Fisher (1997), to examine the learning environments of computer classrooms and students' attitudes towards computer courses in university. The sample involved 905 computer science major students in 33 classes from 11 universities. A mixed-methods approach was used to combine quantitative with qualitative data. The qualitative approach involved interviews with students.

The results suggested that the modified Thai version of the CUCEI and the other two instruments were valid and reliable for measuring students' perceptions of computer laboratory learning environments and attitudes in a Thailand University. The CUCEI revealed that students had positive perceptions about their classroom learning environment and the qualitative data supported the results through the interviews that took place with the students about their classroom learning environment (Charik & Fisher, 2008).

New Zealand

The version of the CUCEI that was modified by Nair and Fisher (1999) was used in the study conducted by Logan, Crump and Rennie (2006). As mentioned earlier, two CUCEI scales (Involvement and Satisfaction) were replaced by Cooperation and Equity. The study examined the statistical performance of the CUCEI in two separate studies. The first study investigated first-year students' perceptions of their learning environment based for subgroups of newly-arrived immigrant and international students of diverse nationalities, cultures and educational backgrounds. The second study involved year 12 and 13 students at seven Wellington secondary schools in New Zealand who were enrolled in optional computing classes. The main aim of the study was to investigate whether there was a computer culture at this level of the education system, and whether there were significant differences between the perceptions of boys and girls, and between students attending mixed- and single-sex schools.

In both studies, some limitations of the CUCEI emerged. A number of negatively-worded items needed to be omitted. The Task orientation scale in the tertiary study and Personalisation in the secondary study needed to be removed to improve the CUCEI's factor structure. In my study, all participant students were weak in Arabic and English was their second language. Because many students were confused by some of the negatively-worded questions, I anticipated that specific items would need to be eliminated during the validation phase in order to enhance the reliability and factor structure of the CUCEI. (Factor analysis of CUCEI data in my study is reported in Chapter 4, Section 4.3.2.)

2.2.4 *Research Applications with Classroom Environment Instruments*

Learning environment instruments have numerous and diverse applications. According to Fraser (1998a), prior research can be classified into: (1) associations between students' outcomes and environment (Chionh & Fraser, 2009; Dorman, 2001; Majeed, Fraser & Aldridge, 2002; Quek, Wong & Fraser, 2005a, 2005b), (2) evaluation of educational innovations (Lightburn & Fraser, 2007; Mink & Fraser, 2005; Spinner & Fraser, 2005), (3) differences between students' and teachers' perceptions of the same classrooms (Fisher & Fraser, 1983; Maor & Fraser, 1996; Sinclair & Fraser, 2002), (4) whether students achieve better when in their preferred environment (Fisher & Fraser, 1983), (5) teachers' practical attempts to improve their classroom climate (Aldridge, Fraser & Sebela, 2004; Sinclair & Fraser, 2002), (6) combining qualitative and quantitative methods (Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; Spinner & Fraser, 2005), (7) school psychology (Burden & Fraser, 1993; Sink & Spencer, 2005), (8) links between educational environments (Dorman, Fraser & McRobbie, 1997; Jegede, Fraser & Fisher, 1995; Marjoribanks, 1991), (9) cross-national studies (Aldridge & Fraser, 2000; Aldridge, Fraser, Taylor & Chen, 2000; Fraser, Aldridge & Adolphe, 2010), (10) transition from primary to secondary education (Ferguson & Fraser, 1998), and (11) teacher education (Martin-Dunlop & Fraser, 2008).

Classroom environment instruments can be used in the evaluation of educational innovations. For instance, when Fraser (1979) compared Australian Science

Education Project (ASEP) students with a control group, the results indicated that the ASEP students perceived their classrooms as being more satisfying and individualized and having an enhanced material environment. The implication of this evaluation is that classroom environment variables distinguished interestingly between curricula, even when various outcome measures showed only minor differences.

In a study conducted by Maor and Fraser (1996) involving an evaluation of the use of a computerised database, data revealed that the use of the innovation led to classes being more inquiry-oriented. Similarly, in Singapore, two more evaluations were conducted, one involving computer-assisted learning (Teh & Fraser, 1994) and the second one about computer application courses for adults (Khoo & Fraser, 2008).

The CLES was used by Nix, Fraser, and Ledbetter (2005) to evaluate an innovative science teacher development program (based on the Integrated Science Learning Environment model). A sample of 445 students in 25 classes participated in the evaluation of the types of teachers' classroom environments. An innovative side-by-side responses format for the CLES was developed by Nix and colleagues in order for students to provide their perceptions of THIS classroom (which was the class with the teacher who had experienced the professional development) and OTHER classroom (that involved other classes at the same school but taught by different teachers). Those students who were taught by teachers who had experienced the professional development had higher scores on the CLES scales of Personal Relevance and Uncertainty compared with the other classes.

In a large urban university in California, Martin-Dunlop and Fraser (2008) involved a sample of prospective elementary teachers to evaluate an innovative science course. Scales were selected from two questionnaires, the WIHIC and the SLEI. The sample consisted of 525 females in 27 classes. Students' perception of the innovative course, compared to their previous course, were considerably more favourable (about 1.5 standard deviations).

Pickett and Fraser (2009) consider that the litmus test of the effectiveness of any teacher professional development program is the extent of modifications in teaching behaviour and eventually student outcomes in the participating teachers' school classrooms. Accordingly, the evaluation of a two-year science mentoring program for elementary-school teachers in south-eastern USA involved seven beginning grade 3–5 teachers and their 573 elementary-school students. The evaluation of the program drew on the field of learning environment in appraising its success in relation to the participants' classroom teaching behaviour as evaluated by their school students' perceptions of their classroom learning environments. Pretest and posttest administrations of the What Is Happening In this Class? (WIHIC) were used to measure changes in students' perceptions of their classroom learning environment. The efficacy of the mentoring program was investigated by using MANOVA and effect sizes for changes over time in the classroom learning environment, in addition to the students' attitudes and attainment.

The WIHIC was also administered by Wolf and Fraser (2008) in New York to a sample of 1,434 middle-school science students in 71 classes to evaluate the effectiveness of using inquiry-based laboratory activities in terms of learning environment, attitudes and achievement. The results supported the validity of the WIHIC and analyses revealed that inquiry instruction promoted more Student Cohesiveness than non-inquiry instruction and was effective for both genders.

In 2008, the WIHIC was adapted for use in Singapore by Khoo and Fraser (2008) to evaluate courses for adult studying computer application courses. Some scales were given a different name (e.g. Teacher Support was renamed Trainer Support). The questionnaire was administered to 250 working adults in 5 computer education centres in Singapore. Several analyses supported the factorial validity and reliability of the WIHIC when used with this sample in the Singaporean environment. In particular, males perceived considerably more Involvement, whereas females perceived more Equity. Also, the opinion of males of Trainer Support was independent of age, but older females had more positive perceptions than younger ones.

2.3   Adult Education

As my research involved adult students, this section reviews literature pertinent to some learning theories that are relevant to this cohort. An adult, according to the Merriam–Webster (n.d.) dictionary, is a person who is fully developed and mature and, in most cases, is over 21 years of age. Adult learning, then, is the process through which adults go to learn a new concept or skill. This can be through formal learning situations such as colleges or workplace training, or more informally through reading a daily newspaper or life experiences.

McCannon and Crews (2000) report that, once an adult educator is aware of the theories associated with adult learning principles, he/she might implement these in the classroom, therefore creating a better learning environment for the adult student. Adult learning theories have profound implications for the content of mathematics instruction, its pedagogy and how learning should be assessed (Forman & Steen, 1999). Definition, theory and instruction are thus tied together. That is, one's view of what numeracy is leads to a theory of learning and this theory affects preferred approaches to instruction. According to Forman and Steen (1999), however, there remains some controversy with respect to how theory should be translated into practice because there is little empirical research which demonstrates the effects of an instructional approach on how adults learn. My study attempted to fill this gap by investigating the effectiveness of using teaching strategies on adult males as they learn mathematics.

Over the last 30 years or so, it has become generally accepted that, both in official reports (Cockcroft, 1982; Her Majesty's Inspectorate [HMI], 1985) and in academic writing related to 'good practice' (Cooper, 2001; Cooper & Dunne, 2000; Hayman, 1975), the teaching and learning of mathematics should be related to its uses in everyday life and work settings. According to Cooper (2001), the majority of students find mathematics more interesting and relevant when it is set in and related to realistic settings and contexts.

According to Knowles (1984), adult learners quite often need to know why they are learning new knowledge before they are willing to participate. Unlike youth, who tend to have a more subject-centred orientation to learning (in which they focus on learning content to pass a test), adults, by virtue of life and work experiences, tend to develop a task-centred or problem-centred orientation to learning (Knowles, 1984). It has also been proposed that adults, unlike children, are more likely to take responsibility for their own learning and would prefer not to be directed by the lecturer during class (McGrath, 2009).

This section involves learning theories associated with adult learners (Section 2.3.1) and learning mathematics as an adult (Section 2.3.2).

2.3.1   Review of Learning Theories Relevant to Adult Education

To provide background information about the learning theories associated with adult learners and the best strategies that can be used in teaching adults, this section provides reviews of literature related to constructivism and social constructivism learning theory (Section 2.3.1.1) and andragogy learning theory (Section 2.3.1.2). The examination of relevant learning theories provided me with information about promising educational experiences (such as cooperative, guided interactions between the teacher and students) that guided the development of my own intervention.

2.3.1.1   Constructivism and Social Constructivism Learning Theory

Learning theory helps to explain human responses through the concept of learning. The philosophical standpoint of constructivism portrays knowledge not as a reflection of the real world that exists, independent of the knower, but rather a reality constructed by the knower, based on the experiences and interactions of the knower with the environment. "It is made up of the network of things and relationships that we rely on in our living, and on which, we believe, others rely on, too" (von Glasersfeld, 1995, p. 7).

In the 1950s, a Swiss psychologist, Piaget, published his seminal work on the cognitive development in children. He identified four stages of development that take the individual from a basic sensorimotor stage through to the formal operational stage, which is usually acquired from the age of 11 years into adulthood. During this final stage of development, critical and abstract thinking is developed as well as the ability to use strategies to aid problem solving. In addition, Piaget claimed that meta-cognition also is developed at this stage (Woolfolk, 2004). According to Piaget, the construction, adaptation and the reorganisation of knowledge at each stage is based upon previously acquired knowledge. When represented with new knowledge, we assimilate it into our existing schema, experiencing a state of equilibrium. If new knowledge conflicts with the existing schema, there is a change in schematic representations in order to accommodate the new information.

To encourage this construction of knowledge, Piaget advocated discovery learning using a hands-on approach with minimal intervention by a teacher. Piaget's research has been influential in both cognitivist and constructivist theories which, in turn, have influenced teaching practice particularly in the fields of mathematics and science. The Russian psychologist, Vygotsky (1986), challenged Piaget's theory of sequential child development, which concerned itself primarily with the individual's cognitive processes in the development of knowledge. Vygotsky's (1986, p. 36) research led him to believe that all thought and language are social from the earliest stages of development and stated that: "In our conception, the true direction of the development of thinking is not from the individual to the social, but from the social to the individual".

Vygotsky's theory, therefore, focuses on social settings and how knowledge can be co-constructed with others through social interaction. This led to the term Social Constructivism. The zone of proximal development (ZPD) is probably the most influential construct of Vygotsky's theory (Vygotsky, 1978). He interpreted it as the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers (Vygotsky, 1978).

The theory of ZPD has led to the term 'scaffolding'. Coined by Wood, Bruner and Ross (1976) from their research on parent–child talk, scaffolding is the special kind of support required by learners as they attempt to complete a task that is beyond their individual capabilities. With the aid of a mentor, they are able to complete the task while at the same time appropriating the necessary skills and knowledge to allow them to eventually complete such tasks unaided. Vygotsky viewed this type of support as future-oriented, in that what can be done today with support can be done alone tomorrow (Gibbons, 2002).

Whilst the ZPD and scaffolding are fundamentally associated with novice/expert interaction, some researchers believe that they have a broader scope which should include collaborative construction of knowledge amongst peers. According to Lantolf (2000), ZPD is the collaborative construction of opportunities for individuals to develop mental abilities. Research has also shown that peer support can also be helpful. These notions were exploited during the lessons taught to adult males in my study, to aid communication and to instil the notion of imparting knowledge and providing help to a peer (which were also considered to be useful skills in the workplace).

Student-centred learning, as with constructivism, is also inherent in social constructivism which endorses self-directed learning, content negotiation and learner autonomy. Lahiry's (2001, p. 59) description of student-centred learning environments closely parallels a social constructivist view of learning, which includes actively participating in learning that builds on previous knowledge; developing the desire and skill to continue learning; and taking responsibility for learning and socially constructing knowledge through higher-order thinking skills.

One would imagine that an approach that endorsed the individual would be readily embraced by all concerned but, as Tarone and Yule (1989, p. 9) point out, "we simply cannot ignore the fact that many learners are used to an educational setting in which teachers overtly control the activities of the group in a relatively formal manner, emphasize the memorization of rules and rubrics, often via mechanical procedures such as repetition and rote learning, administer frequent achievement

tests, and generally require their students to maintain a passive and subordinate role". This indeed is the educational setting to which my adult male students were accustomed. As such, I needed to consider how I might 'acclimatise' them to the new approach that I was to deliver, thereby allowing them to develop the attitude and initiative to become more independent learners.

2.3.1.2   Andragogy Learning Theory

The word 'andragogy' comes from the Greek word *andr* meaning man and *agogos* meaning leading. Andragogy consists of learning strategies that focus on adults and the process of engaging adult learners within the structure of a learning experience (Bangaoil, 2011). Andragogy involves four key notions about the design of learning for adult education: adults need to know why they need to learn something; adults need to learn experientially; adults approach learning as problem-solving; and adults learn best when the topic is of immediate value (Bangaoil, 2011).

Andragogy means that instruction for adults needs to focus more on the process and less on the content being taught. Strategies such as case studies, role playing, simulation and self-evaluation are most useful (Knowles, 1984). The intervention evaluated in my research drew heavily on the theory of andragogy by involving a variety of activity-based teaching strategies during which I adopted the role of facilitator rather than lecturer.

Related to this, Pfeiffer and Jones (1981) proposed that successful adult learning needs to involve experiencing, processing, generalizing and applying. Experiencing supports the notion that adults having a receptive, experience-based approach to learning in which they rely heavily on feeling-based judgements and learn best from specific examples and discussions. Processing is related to the reliance that adults have on careful observation and the fact that they learn best from situations allowing impartial observation. Generalisation involves adults learning from impersonal situations and the opportunity to integrate new things with what is already known and with theory. Applying involves adults learning pragmatically and relying heavily on experimentation and learning best from projects. Following Pfeiffer and Jones's

(1981) principles of adult learning, my intervention ensured that my learners: were motivated not taught; learned what they wanted to learn; were taught material that had personal meaning; were exposed to methods that helped them to become more effective learners; were involved in a cooperative and collaborative process; and had opportunities to reflect on their learning and what they thought and felt.

Malcolm Shepherd Knowles was a central figure in USA adult education in the second half of the twentieth century. He wrote the first major accounts of informal adult education and the history of adult education in the USA. Furthermore, Knowles (1950) attempted to develop a distinctive conceptual basis for adult education and learning via the notion of andragogy which became very widely discussed and used. His work was a significant factor in reorienting adult educators from 'educating people' to 'helping them learn' (Knowles, 1950, p. 6).

Knowles (1984) was convinced that adults learn differently from children and that this provided the basis for a distinctive field of enquiry. His charting of the development of the adult education movement in the USA helped him to come to some conclusions about the shape and direction of adult education. To bring these together, he used the notion of andragogy. Although the concept of andragogy has been used since the 1830s, Knowles popularised its usage. Andragogy, according to Knowles (1980), is premised on four assumptions about the characteristics of adult learners that are different from those of child learners because, as people mature:

1. Their self-concept moves from one of being a dependent personality toward one of being a self-directed human being.
2. They accumulate a growing reservoir of experience that becomes an increasing resource for learning.
3. Their readiness to learn becomes oriented increasingly to the developmental tasks of their social roles.
4. Their time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly their orientation toward learning shifts from one of subject-centredness to one of problem centredness.

Knowles (1980, p. 54) held the view that adults "tend to be problem-centred in their orientation". This is something that lecturers or facilitators need to take into account when they are planning their classes, as they should allow for problem solving as well as interaction with the student. Some adult students prefer to be problem centred but others want the lecturer to lead them through the course. Therefore problems arise when adults suddenly find themselves in a situation in which they have to think for themselves and participate in the class. There are reports of some lecturers taking the theory of andragogy to the extreme by adopting an overly empathetic manner in a bid to address the anxiety and low self-esteem of their adult learners. Findings suggest that this reaction can result in no learning in the classroom because the lecturer is afraid to challenge students in case it damages their self-esteem (Rodgers, 2000).

The past two decades have drawn adult educators' attention to the fact that adults should be involved in "as many aspects of their education as possible and in the creation of a climate in which both they and the students can fruitfully learn" (Houle, 1996, p. 60). It has given adult educators the option of using an alternative style in the classroom. Knowles, Holton and Swanson (1998, p. 65) stated that it is the "job of the adult educators to move adult students away from their old learning and into new patterns of learning where they become self-directed taking responsibility for their own learning and the direction it takes".

2.3.2   *Learning Mathematics as an Adult*

Adult learners bring a collage of mathematical knowledge with them from earlier schooling, everyday life, work experience, and even the advertising that they see around them (Steinke, 2008). Building upon this, Gal (2000) purports that mathematical learning should start from the learner's perspective. The need to understand and to be able to use mathematics in everyday life and in the workplace is paramount (NCTM, 2000). Although the number of studies related to mathematical learning difficulties has been small compared with the number of studies related to reading difficulties, this trend has changed in more recent years as the importance of being successful in mathematics has been recognised (Gersten, Clarke & Jordan,

2007). These studies indicate that real-life numeracy situations should always be embedded in the life stream and should have personal meaning for the individuals involved.

Research has convincingly demonstrated that out-of-school practices should not be regarded as merely the application of school techniques, and that the mathematical techniques used in specific everyday life contexts are deeply bound up with, and developed in, the socially organised activities and systems of meaning within that particular community (Lave, 1988; Nunes, Schliemann & Carraher, 1993). According to Ainley (2000), what makes an aspect of mathematics 'real' is the quality of an individual's engagement with a problem, rather than its utility or immediate application to his or her everyday life. Therefore, pure or abstract problems, or areas of mathematics such as algebra, can be very real in terms of the interests and commitment that they engender.

To exploit fully the power of mathematics in students' lives, students need a relational or principled understanding of significant mathematical concepts (Skemp, 1986). This means that not only should the student develop mathematical skills (e.g. know number facts; apply arithmetical procedures correctly; recognise and relate shapes; and use statistical formulae), but they should also perceive the meaning of concepts and develop connected understandings that they can apply to problems in their everyday world (Askew, Brown, Denvir & Rhodes, 2000). Students should be able to draw on mathematics to make informed decisions in life and work. Such knowledge requires understanding of the nature of mathematics itself in generalisation and abstraction.

In this day of rapidly changing technologies, teachers can anticipate neither all of the skills that students will require over their lifetime nor the problems that they will encounter. It is important to prepare students to learn new skills with useful meaning and to adapt their knowledge to solve problems. Carpenter and Lehrer (1999) emphasise that, unless students learn with understanding (intrinsic meaning), whatever knowledge they acquire is likely to be of little use to them outside their educational setting.

2.4   Chapter Summary

The main purpose of this study was to investigate the effectiveness of teaching strategies that were employed to engage UAE college mathematics adult male students, who had experienced difficulties in learning mathematics, in terms of the nature of the classroom learning environment and students' satisfaction. In this chapter, literature related to this research project about the learning environment of adult students was reviewed to provide a theoretical and methodological framework for this research. Two main areas were reviewed because of their significance to this study: learning environments research; and research related to adult education.

Section 2.2 provided a review of the historical context of learning environments research which was followed with a review of several historically significant learning environment instruments, namely, the Learning Environment Inventory (LEI), Classroom Environment Scale (CES), and Individualized Classroom Environment Questionnaire (ICEQ). This was followed by consideration of the My Class Inventory (MCI), Questionnaire on Teacher Interaction (QTI), Science Laboratory Environment Inventory (SLEI), Constructivist Learning Environment Survey (CLES), and What Is Happening In this Class? (WIHIC). The next section (Section 2.2) was devoted to studies that involved translating learning environments instruments into various languages.

An entire subsection (2.2.3) was devoted to reviewing literature about the development, characteristics, validation and past uses of the College and University Classroom Learning Environment (CUCEI) because it was used in my study to investigate the effectiveness of activity-based teaching strategies in terms of the nature of the classroom learning environment and students' satisfaction. This subsection provided reasons for the selection of this instrument for use in this study, a review of literature related to the history and development of the instrument, its validation and application, and a review of various past studies to illustrate how the instrument has been used around the world.

In Section 2.3, literature related to adult education was reviewed, including. It examined how using a range of personally-relevant and concrete activities could change the learning environment in ways that are perceived to be beneficial by adults who had experienced failure. This was achieved by reviewing learning theories relevant to adult education, such as constructivism, social constructivism and andragogy learning theory. The chapter ended with a subsection (Section 2.3.2) which reviewed literature about learning mathematics as an adult.

Chapter 3

RESEARCH METHODS

3.1   Introduction

This research aimed to evaluate the effectiveness of using a variety of mathematical teaching strategies, such as games and educational puzzles, to develop a more conducive mathematics learning environment for adult male students who had experienced difficulties in learning mathematics. The research involved an action research approach and a wide range of data collection methods, including surveys, case studies, observations, focus-group interviews and semi-structured interviews. This chapter details the research methods used in the present study using the following headings:

- Research Questions (Section 3.2);

- Research Design (Section 3.3);

- Sample (Section 3.4);

- Quantitative Data Collection and Analysis (Section 3.5);

- Qualitative Data Collection and Analysis (Section 3.6); and

- Chapter Summary (section 3.7).

3.2   Research Questions

The overarching aim of the present study was to evaluate the effectiveness of an activity-based learning environment for adult male students who had experienced difficulties in learning mathematics. The following specific research questions were delineated to help to address this overarching aim:

1. Is a modified Arabic version of the CUCEI valid for assessing classroom environment among tertiary students in the UAE?

2. Is the use of the activity-based teaching strategies effective in mathematics in terms of:

   (a) the nature of the classroom learning environment; and

   (b) students' satisfaction?

3. Can qualitative research methods be used to examine how using a range of personally-relevant and concrete activities change the learning environment in ways that are perceived to be beneficial by adults who had experienced failure?

3.3   Research Design

Creswell and Plano Clark (2007) indicate that it is no longer adequate to equip researchers with just quantitative or qualitative research methods given the increasing complexity of research problems in the social sciences. Mixed-methods research encourages the use of multiple worldviews, or paradigms, as opposed to the typical use of certain paradigms for quantitative researchers and others for qualitative researchers. Moreover, Creswell and Plano Clark (2007) claim that it is the research design, which comprises philosophical assumptions, that dictate the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in the research process. Mixed-methods research offers considerable promise for practising researchers who would like to see methodologists describe and develop techniques that are closer to what they actually use in practice. Furthermore, mixed-methods research, as a third research paradigm, has helped to bridge the schism between quantitative and qualitative research (Johnson & Onwuegbuzie, 2004; Onwuegbuzie & Leech, 2004).

The nature of the present study led to a multi-method approach to allow the triangulation of different research methods and the validation of the data. The data collected using the different research methods were complementary and formed a more complete and coherent picture of the learning environment, as recommended by Denzin and Lincoln (1994). Moreover, quantitative and qualitative data collected in this study served as a form of methodological triangulation (Cohen & Manion, 1994) for improving the validity and quality of data (Anderson, 1998; Burns, 1997).

In addition, my decision to complement one method with another helped in gaining greater understanding and facilitating communication and collaboration between the students and myself.

Both quantitative and qualitative research methods were used to examine the effectiveness of activity-based teaching strategies to engage UAE college mathematics students who had experienced difficulties in learning mathematics. The use of mixed methods in this research enabled me to draw from the strengths and minimise the weaknesses of both methods. Qualitative, interpretive research helped me to organise and describe subjective data in a systematic way (Glensne & Peshkin, 1992), whilst the quantitative, positivist, mode guided me on a quest for certainty and an insistence of objectivity (Patton, 1990).

Being a researcher–as–lecturer was advantageous as the students involved in the research had known me for at least two years. Therefore, I was able to establish a good student–teacher relationship that allowed me to discuss the plans for my research with them. Being researcher–as–lecturer enabled me to set appointments for interviews to take place without distracting the lessons. All of the students were willing to contribute to the data collection and to support the research. Their enthusiasm stemmed from their desire to experience teaching strategies to which they had never been exposed. To help to overcome any obstacles and the possibility that the participants might feign understanding (to provide answers that seemed to satisfy the interviewer), I was able to develop a trusting relationship with the students, as recommended by Burgess (1988). In addition, the unequal power relationship between the participant researcher and the students had to be taken into consideration. A more equitable relationship involving negotiation and trust was maintained in two ways. Firstly, having taught these students for the last two years, a positive relationship had already been established with them. Secondly, through informed consent and open communication, students were aware of the mutually collaborative nature of the research.

During the two years prior to the research, I had built up a high level of trust with the students, making them more willing to compare their school experiences with the

lessons that I had introduced. I feel that this mutual trust and my regular contact with my students, during the time leading up to the research, facilitated data collection. In addition, the trust and understanding between my students and me stimulated the willingness of all students to take part in and support the research.

I applied triangulation to the research as "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller, 2000, p. 126). However, as mentioned earlier, the overall purpose and central premise of mixed-methods studies is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems and complex phenomena than either approach alone (Creswell & Plano Clark, 2007). Mixed-methods research, according to Creswell and Plano Clark (2007), is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves the philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analysing and mixing both quantitative and qualitative data in a single study or series of studies. Mixed-methods researchers believe that "the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone" (Creswell & Plano Clark, 2007, p. 5).

Therefore, I applied triangulation to the research as it is a process in which the researcher seeks to look at the data from different approaches and perspectives and to ensure that all of the data are telling the same story (Kamarul, 2009).

3.4   Sample

Purposeful sampling was used to allow me to decide, prior to the study, which students would be included in the data collection. In this way, I was able to select students who were most likely to provide information that would lead to a holistic understanding of the research questions, as recommended by Norman and Fraenkel (2001).

The sample was drawn from eight mathematics classes at the Higher College of Technology (HCT) in the United Arab Emirates. The total sample used for the present study involved 84 students in eight classes that were all taught by me and involved in the activity-based lessons. This sample provided a range of ages, ability levels and other demographic characteristics. Two of the classes consisted of students who were in their second semester (they have one more semester to graduate) and three of the classes had students in their first semester (which means that they have two more semesters to complete the course). The three remaining classes had students in semester three (the final semester) who were present only for the first four weeks of the semester before they left for work placement. Therefore, students for the case study were selected only from semester one and two classes.

The students were all males aged between 19 and 45 years. All of the students were low achievers in mathematics, as perceived by both myself and them. They qualify as being students who have experienced difficulties in learning mathematics because they were not able to perform simple mathematics operations, such as subtraction or finding the product of two numbers. In addition, according to the conversation that I had with the students at the beginning of the year, they had never understood mathematics at school and felt that it was an ambiguous subject.

One of the eight classes was made up of 19–22 year-old students who had just completed high school (but their average was not high enough to qualify them to enter university). These students were sent to Abu Dhabi Men's College (ADMC) to complete the Work Readiness Program (WRP), which involved a three-semester bridging course which, after successful completion, would allow them to enter university. The remaining seven classes were made up of students who had left school 10 or more years ago. These students were attending the ADMC to complete the Work Readiness Program to support them in finding jobs.

Five students, one from each of five classes that was taught in semester one and two, were selected as case studies. Students from the other three classes (semester three students) were involved in the quantitative data collection only. All of the students were provided with information about the nature of the research including: the data

collection methods; the purpose of the research; the risks and benefits to the participants; and the possible outcomes of the research. Students were informed that participation was voluntary and that they were free to withdraw from the research at any time, without prejudice or negative consequences. To this end, all students were provided with an information sheet and consent form containing this information (see Appendix B).

Qualitative case studies were used to enable me to study complex phenomena within the context of my mathematics class (Baxter & Jack, 2008). The use of qualitative case studies facilitated examination of the effectiveness of activity-based strategies within this unique context, ensuring that the effectiveness of using multiple strategies was not explored through one lens, but rather by using a variety of lenses, to allow multiple facets of the phenomenon to be revealed and understood. In addition, a variety of other data sources was utilised, such as semi-structured interviews, observations and focus-group interviews.

The five case-study students, one student from each of five classes, were purposefully selected. These five students were 22, 29, 30, 35 and 41 years of age. All of the students in the five classes were studying the same course and were all taught using the same activity-based strategies.

With respect to the observation sample, all students in the five classes were involved in the observation process. Six students were selected from each of the five classes to be involved in the focus-group interviews. Focus groups are likely to yield the best information when students are selected carefully by the researcher to ensure their availability to provide sufficiently descriptive responses that are beneficial to the study (Patton, 1990). Therefore, purposeful sampling was used to produce information-rich cases that illuminated the study and elucidated variation, as well as significant common patterns within that variation (Patton, 1990). To this end, the researcher selected students who were outspoken, confident and willing to be involved. UAE citizens have the opportunity to access higher education at a variety of governmental and private tertiary institutions after completing high school. In all of these tertiary institutions, students are required to undergo a foundation program

that includes a compulsory one-year mathematics course. The foundation programs are designed to bridge the gap between secondary and college-level education.

The student population of the WRP was diverse with ages varying from 18 years to the late 40s. A small number of students had been educated abroad and have good English and comprehension skills. Most of the students left school between grades 5 and 9 when they were aged between 10 and 15 years.

The majority of students can speak and comprehend a limited number of words in English. Most students can read simple Arabic texts, but their writing skills are poor. The majority of the students are illiterate in Arabic, their first language.

In my experience, these students tend to have poor cognitive abilities, limited learning skills and limited concentration spans. The majority of these students are fathers. Motivation and commitment are generally good during the first semester. This tends to wane during the second semester and absenteeism starts to become an issue.

My instructional methods attempted to overcome all of the factors that led to making students into reluctant learners in their mathematics lessons through the use of various activity-based teaching strategies to attract them to the subject and to give them self-satisfaction.

3.5   Quantitative Data Collection and Analysis

The focus of the activity-based instruction, introduced during this study, was learning by doing and thereby making the abstract concrete. Some activities were teacher-driven, with direction from an instructor, and some were learner-driven, with the learner having the freedom to explore (e.g. cutting advertisements from a newspaper and having the students calculate the profit or loss on a particular item; or completing number crossword puzzles for which students discovered by themselves that there is a close relationship between the two arithmetic operations of division and

multiplication). To evaluate the effectiveness of these strategies, both quantitative (this section) and qualitative data (Section 3.6) were used.

Quantitative data were used to investigate whether the activity-based sessions influenced students' perceptions of the learning environment of mathematics classes. The use of a survey was selected because of its efficiency in terms of: researcher time; researcher effort; and financial resources (as discussed by Gulham, 2000).

A survey, described below, was administered to students to provide a snap shot of their views of the learning environment before and after the introduction of the activity-based sessions. The pretest was administered to all students during the first week of the semester, after which I introduced the activity-based lessons for nine weeks. At the end of the nine weeks, I readministered the same survey to the students to determine whether they perceived their mathematics learning environment differently.

The section below focuses on the criteria used in selecting an instrument (the CUCEI) for the research (Section 3.5.1). The next sections are devoted to the translation of the CUCEI questionnaire into Arabic (Section 3.5.2), the pilot testing of the questionnaire (Section 3.5.3), and the quantitative data analysis (Section 3.5.4).

3.5.1   *Instrument Selected for the Research*

Based on its validity and applicability to tertiary students, the College and University Classroom Environment Inventory (CUCEI) was selected for use in the present study. Fraser, Treagust, Williamson and Tobin (1987) found that, despite the existence of a strong tradition of classroom environment research at the primary and secondary school levels, relatively little work had been undertaken at the higher education level because of a lack of suitable instruments. In response, Fraser, Treagust and Dennis (1986) developed the College and University Classroom Inventory (CUCEI) to assess students' perceptions of the psychosocial environment

at the university and college levels. Literature related to the CUCEI was reviewed in Section 2.2.3 in Chapter 2.

The original CUCEI had 12 items in each of the 7 scales and was field tested with a sample of 127 undergraduate and postgraduate students in 10 classes at one multi-purpose tertiary institution in Perth, Western Australia. Some items in the instrument were removed to enhance the internal consistency (that is, the extent to which items in the same scale measure the same dimension) and discriminate validity (the extent to which a scale measures a unique dimension that is not covered by the other scales in the instrument) (Fraser, Treagust & Dennis, 1986).

A refined version (with seven items in each of the 7 scales) was cross-validated with 30 postgraduate and undergraduate classes in Australia and 65 postgraduate and undergraduate in America. That study reported satisfactory internal consistency, with Cronbach alpha reliabilities ranging from 0.72 to 0.92 for the actual form, and from 0.60 to 0.82 for the preferred form (Fraser, Treagust & Dennis, 1986). The final form of the CUCEI has 7 scales, namely: Personalisation; Involvement; Student Cohesiveness; Satisfaction; Task Orientation; Innovation; and Individualisation. Each scale comprises seven items, making a total of 49 items in all (Fraser & Treagust, 1986).

Students respond to each item on a five-point Likert-type scale of: Strongly Agree; Agree; Neutral; Disagree; and Strongly Disagree. The polarity is reversed for approximately half of the items. Examples of items are: "Activities in this class are clearly and carefully planned" (Task Orientation); and "Teaching approaches allow students to proceed at their own pace" (Individualization). The items are arranged in cyclic order so that the first, second, third, fourth, fifth, sixth and seventh items in each block, respectively, assess Personalization, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation and Individualization. A copy of the original seven-scale CUCEI as used initially in the present study can be found in Appendix A.

Table 2.2 in Chapter 2 elucidates the meaning of each CUCEI scale by providing its classification according to Moos's scheme, a scale description, and a sample item. This table clarifies that some items are negatively worded, thus requiring reverse scoring.

3.5.2   Translation of the CUCEI into Arabic

Because the bilingual development of questionnaires presents additional concerns over and above the usual needs of pilot testing, I opted to use a dual layout for arranging questions in English and Arabic. This approach allowed opportunities for concurrent administration of the CUCEI in both languages (Potter, 1999). To ensure that the translation was of high quality and to minimise its limitations, consultation involved discussions with other teachers about the use and meaning of words which were identified as being problematic, as well as discussions with people who were bilingual. These discussions were used to make joint decisions with colleagues about the best terms to use, as recommended by Brislin (1976).

The questionnaire used in the present study involved a dual layout with each item written in English and with the Arabic translation placed underneath. This format has been used successfully in past research involving translated versions of questionnaires (Aldridge & Fraser, 2000; Khine & Goh, 2001). This dual layout is illustrated in Figure 3.1 and Appendix A.

	STRONGLY DISAGREE غير موافق بتاتا	DISAGREE غير موافق	NEUTRAL محايد	AGREE موافق	STRONGLY AGREE موافق بشدة
1. The instructor considers students` feelings. الأستاذ يراعي مشاعر الطلاب	☐	☐	☐	☐	☐
2. The instructor talks rather than listens. الأستاذ يتكلم بدل الاستماع	☐	☐	☐	☐	☐

Figure 3.1   Dual Layout of the Translated CUCEI

The CUCEI questionnaire was originally developed in English and has not been translated into Arabic in previous studies. Because all participants in this research

spoke Arabic as their mother tongue, it was considered prudent sometimes to make minor modifications to the wording to make it suitable to the UAE context in general and to translate the CUCEI into Arabic.

The modifications involved re-writing some of the questions using simpler English words in order to provide a simpler Arabic translation. In addition to this translation, I read items aloud during administrations for the majority of the classes in order to accommodate different accents.

The translation process involved back translation, consultation and collaboration with other people during the process and piloting. Back translation, arguably, is accepted as good practice for questionnaire translation (Hilton & Skrutkowski, 2002; McKay, Breslow, Sangster, Gabbard & Reynolds, 1996). This method involves a direct translation of the questionnaire by a person fluent in both languages. In this study, it was my sister who was fluent in English and Arabic and who carried out the direct translation. To assess and ensure the quality and equivalence of the translation, a second back translation into English was made by an independent person not familiar with the instrument (my brother). Comparisons were then made between the original and back-translated version to identify discrepancies or anomalies in the Arabic version. It was acknowledged that the quality of translation was dependent upon a number of factors including: the knowledge of the language; the culture of the people under study; and the translator's fluency in the language (Vulliamy, 1990).

Over the year, I have had many students who were eager to learn English and who would ask me during lessons to introduce a concept in English and speak to them in English. It was for this reason that I provided each question in English and the translation in Arabic underneath it as shown in Figure 3.1.

3.5.3   *Pilot Testing of Questionnaire*

Baker (1994) defined a pilot trial as 'trying out' a particular research instrument. One of the advantages of conducting a pilot study was that it gave me the opportunity to examine whether the translated questionnaire was useable with the adults who had

experienced difficulties in learning mathematics. In particular, specific purposes of the pilot study were to: check the readability of individual items; check that students were able to use the response format; provide an estimate of how much time would be required to administer the questionnaire; and ensure that students interpreted the questions in a similar way to the researcher.

The pilot test involved 10 students, all of whom were Arab Nationals fluent in Arabic and aged between 16–30 years. I managed to arrange two separate interviews with each of the students involved in the pilot test. The first interview encompassed: giving out the questionnaire; collecting demographic information about each student in the group; introducing the students to the questionnaire by providing information about how to answer the questionnaire; and instructing the participants to circle any question that did not make sense so that it could be discussed with the researcher during the second interview. The second interview was held during the following week, at the same time of day, because the students' schedule did not permit both interviews to take place on the same day. Therefore, the researcher had to leave the questionnaires with the students and collect them from students the following week.

In the second interview, we discussed questions which had not made sense, so that they could be rephrased and simplified. The researcher kept a written copy of the students' comments and suggestions during the first and the second interviews.

The results of the pilot test indicated that minor rephrasing was required for some of the questions. For example, in Question 19, students did not understand the word "side-tracked" and, therefore, this was changed to "off track". In addition, the term "thinks up", in Item 20, was not familiar to the students and was simplified to "comes up" as suggested by the students. Students were not familiar with the English word "seldom" and, as some of them preferred reading the questions in both languages, they had to look it up in the Arabic dictionary. It was suggested that they would be more familiar with the term "sometimes". However, the students suggested that the word did not need to be changed as it was used in many of the questions and they became familiar with it towards the end of the questionnaire.

Students also admitted that it was easier reading the Arabic version than the English one as they felt it made more sense to them.

3.5.4 Quantitative Data Analysis

The first two research questions referred to whether a modified Arabic version of the CUCEI is valid for assessing classroom environment in the UAE and whether using activity-based teaching strategies in mathematics is effective in terms of the nature of the classroom learning environment and students' satisfaction. These research questions were predominantly answered using the CUCEI to assess students' perceptions of the psychosocial environment and their satisfaction in the mathematics classes.

The CUCEI was administered to the 84 students in all 8 classes (described in Section 3.4) using a pre–post design in which the questionnaire was administered prior to the introduction of the activity-based teaching and again at the end of the semester. After the questionnaire was administered and collected from the 84 students who participated in this study, each student's responses were checked. Because the survey was administered on two occasions (pre and post), students who were missing either the pretest or the posttest or had incomplete responses were eliminated from the data set. Responses were then entered by me directly into a database using Microsoft Excel.

The responses of Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree were entered into the database as 1, 2, 3, 4 and 5, respectively. The data were rechecked by myself and again by another individual. After all of the data were successfully entered and checked, they were uploaded into SPSS for statistical analysis. Consent forms and the original questionnaires were stored in a locked filing cabinet in my office at the college.

To give credibility to my results and to answer the two research questions concerning validity and reliability of the learning environment scales from the CUCEI, several analyses were performed. Data gathered from the 84 students were used to

investigate the questionnaire's factor structure by performing principal axis factor analysis with varimax rotation and Kaiser normalisation for the CUCEI's 42 items in six scales (namely, Personalisation, Involvement, Student Cohesiveness, Task Orientation, Innovation and Individualisation) after removal of Satisfaction. Factor analysis mainly tells the researchers which items go together. Statistical software performs factor analysis by continually reorganising the items in the analysis into new factors and then rotating these factors away from each other to create as many meaningful, separated factors as possible. It was decided that only items having a factor loading of at least 0.40 on their own scale and less that 0.40 on all other scales would be retained as recommended by Field (2005), Stevens (1992) and Thompson (2004). Factor loadings indicate the strength of the relationship between an item and a construct. Factor analysis identified whether there was a need to remove any of the items from subsequent analyses. Factor loadings (a measure of correlation), percentage of variance, and eigenvalues are reported in Chapter 4.

The internal consistency reliability was calculated for each learning environment and satisfaction scale separately to check whether every item in each learning environment scale assesses a common construct. Simply stated, reliability refers to consistency in measurement. The similarity of item responses indicates that a construct is being measured reliability. The most common reliability index is Cronbach's alpha coefficient (1951), which was calculated in this study. Alpha coefficients range from 0 to 1, with 1 indicating the greatest possible reliability. Although the reliability of the CUCEI has been established in prior studies, it can vary depending on the sample and was therefore checked again with my sample in the UAE.

My second research question involved whether activity-based teaching strategies in mathematics are effective in terms of the nature of the classroom learning environment and students' satisfaction. The statistical significance of pretest–posttest changes in learning environment and satisfaction scales was explored using Multivariate Analysis of Variance (MANOVA) with repeated measures. Wilks' lambda is a statistical test used in MANOVA and involves the proportion of variance in the dependent variables that is not accounted for by the independent variable. In

the multivariate setting, Wilks' lambda involves the same role as the F-test in ANOVA. If the multivariate test using Wilks' lambda criterion reveals a statistically significant differences between groups for the set of dependent variable as a whole, then it is justified to interpret the univariate ANOVA results separately for each individual independent variable.

The effect size was calculated to provide an indication of the magnitude of the pre–post difference for each scale, as recommended by Thompson (2001). The effect size is a measure of the magnitude or practical significance of differences that reduces the impact of sample size (Urdan, 2010). The effect size, which is calculated by dividing the difference between means by the pooled standard deviation, expresses a difference in standard deviation units.

3.6   Qualitative Data Collection and Analysis

A product of this research is the richly descriptive use of words to portray the activities that I used during the classroom activities and to convey what I learned about the phenomena. Moreover, the research included a description of the context, the involvement of the participants and the activities of interest. This was achieved by using a range of data collection methods. The combination of the quantitative and qualitative data supported this investigation and was used to convey what I learned and achieved during the research, as recommended by Merriam (2002).

There were three major types of information gathered using qualitative methods: interviews; observations; and the analysis of documents. This section involves the criteria used to ensure the validity of this research (Section 3.6.1) and how the data were collected using: case studies (Section 3.6.2); observation (Section 3.6.3); interviews (Section 3.6.4); and focus-group interviews (Section 3.6.5).

3.6.1   Validity of the Qualitative Research Methods

Positivist and interpretive approaches are different in nature and the measures of trustworthiness in quantitative research are different from those used in qualitative

studies. Quantitative studies portray a world of variables and static states, and must convince the reader that procedures have been followed faithfully because there is little concrete description of what anyone has done (Firestone, 1987). In contrast, qualitative studies describe people acting in events and must provide the reader with a description in sufficient detail to show that the author's conclusions make sense (Firestone, 1987). To illustrate the trustworthiness of the present research, the notions of credibility, transferability and dependability and confirmability are discussed with respect to how these were used during my qualitative data collection.

Credibility

Credibility in qualitative research is equivalent to internal validity in quantitative research. Merriam (1998) refers to validity as an indication of how well research findings match reality. Internal validity depends upon the view of reality that the researcher takes. Qualitative research defines reality as being holistic, multidimensional and ever changing, as opposed to a single, fixed, objective phenomenon waiting to be discovered, observed and measured (Merriam, 1998). With respect to a constructivist perspective, this study took into account that reality is a construction of people's minds, giving the chance for multiple constructions to be identified.

Strategies that were used in this research to improve the validity of the qualitative methods included the use of multiple sources of data and multiple methods of data collection and data analysis. The use of these strategies contributed to enhancing the credibility of the research findings (Merriam, 1998) by providing a more holistic and plausible explanation and understanding of the situations being researched (Mathison, 1988). The reality of the students was constructed as I sought to make sense of the experiences in the classroom during different activity-based strategies. To further increase the validity of findings, as recommended by Merriam (1998), the data were gathered over a period of time (one semester) at the same research site. In addition, a variety of data collection methods, such as interviews, observations, focus groups and teacher reflections, increased the credibility of the findings.

Transferability

Merriam (1998) defines external validity as the extent to which findings from one study can be applied to another situation. Researchers who use qualitative methods use the term generalisability while qualitative researchers use the term transferability, which is based on the degree of similarity between the context under study and the contexts to which findings can be transferred (Guba & Lincoln, 1989). In this research, I attempted to provide sufficiently rich data for future users of the research to determine whether transferability is possible to their own situation (Lincoln & Guba, 1985). In doing so, I used the rich description of the case studies to enable readers to determine how closely their context is similar to the research context.

Dependability and confirmability

The term dependability has been used as the qualitative alternative to reliability, and relates to whether the results are consistent (or dependable) with the data collected (Merriam, 1998). For research to be dependable, the whole inquiry process must be both "tracked and trackable" (Guba & Lincoln, 1989, p. 242) and open to public inspection.

Guba and Lincoln (1989) note that confirmability, the qualitative replacement of objectivity, can be established by the reader being able to track the data and interpretations presented in the study. Different strategies were used in my research to increase the dependability and confirmability. Thorough descriptions of the methodology, construction and interpretation of the case studies and the selection and description of the participants have been presented to allow readers an understanding of the process involved in the research. The following subsections describe the methods used for gathering qualitative information.

3.6.2   Case Studies

There are two key approaches for guiding case study methodology: one by Robert Stake (1995) and the other by Robert Yin (2003, 2006). Both seek to ensure that the topic of interest is well explored and that the essence of a phenomenon is revealed through semi-structured interviews, observations and focus-group interviews. One of the advantages of using this approach is that it allowed close collaboration between the participants and me as the researcher, as recommended by Crabtree and Miller (1999). In doing so, the participants were given the confidence to tell their stories and to give their impressions of the new teaching strategies and to compare them to the strategies to which they had been exposed in the past. Through these stories, I was able to better understand the participants' actions and the effectiveness of the strategies (Lather, 1992; Robottom & Hart, 1993). Details of the case studies are illustrated below.

I gathered information from the five case-study students through individual interviews, observations and focus-group interviews (described below). Each of the five case study students was interviewed on a weekly basis, at the end of the mathematics lesson. Observations of the whole class were completed three times a week during the mathematics class. The focus-group interview was undertaken once at the end of the semester for each of the five classes. The focus group involved six students from each of the five classes and included the case-study student. The focus group took place during the last mathematics lesson of the semester.

The five case-study students were interviewed initially on the basis of student responses to the questions in the guideline that I had prepared for asking students questions during the interview (see Appendix C). Analysis of the interviews raised more in-depth questions relating to creating a learning environment in which students who had experienced difficulties in learning mathematics were now better able to learn mathematics. Observations were also the source of student interview questions about various situations during the activity-based lessons and about students' views of the classroom. I attempted to ask more questions while observing students and

endeavouring to piece together my understanding of the learning environment in each class.

3.6.3   Observations

Observations were used to gather first-hand information about the reactions of the participants to the activity-based lessons (Creswell, 2005). The observational data collected for this research represented a first-hand encounter with the phenomenon of interest rather than a second-hand account obtained using an interview (Merriam, 2002).

Observations are a frequently-used form of data collection in which the researcher is able to assume different roles in the process (Creswell, 2005). Given the nature of the present action research study, I was an active participant observer. The collection of qualitative observational data as a participant observer involved formulating a well-understood relationship between the research participants and me. As a participant observer in the role of researcher–as–lecturer, I was careful to minimise issues associated with power relationships by ensuring that participants' consent was both voluntary and informed and by advising students that they could withdraw from the research at any time (as suggested by Merriam, 2002).

Observations of five of the eight classes took place during each of the lessons and were recorded as field notes at the end of the lessons. At the end of each week, a more intense observation was made in each of the five classes in which case-study students were involved. During these observations, significant events and interactions between the students and myself and among students were recorded as field notes. These observations generally lasted for 50 minutes and were carried out over nine weeks.

3.6.4 Interviews

Interviews were used to provide a means by which participants could talk about their views of the new teaching strategies to which they had been exposed. During the interviews, participants were encouraged to discuss their perceptions and to describe their experiences of the activity-based lessons. Two types of interviews took place in this study, namely, individual interviews (described in this section) and focus-group interviews (described in Section 3.6.5).

A semi-structured interview guide was used to ensure the collection of more reliable qualitative data (Cohen, 2006). Corbetta (2003) clarified that, when using a semi-structured guide, the researcher is free to conduct the conversation as she or he thinks fit, to ask the questions that are deemed appropriate, and to use words that are considered most appropriate. These interviews enabled me to gain insights, explanations and information about student perceptions, attitudes and values related to the activity-based classes. In-depth, semi-structured interviews permitted me to build a conversation between the case study students and myself concerning the activity-based strategies that students were using, as recommended by Patton (2002).

Interviews were considered to be an appropriate form of data collection that would enable me to explore, probe and ask questions that might elucidate and illuminate the appropriateness and usefulness of the new teaching strategies (O'Leary, 2004). As I was not aiming to test a specific hypothesis (David & Sutton, 2004), I used a list of key themes, issues and questions that I wished to cover. By using this type of interview, I was able to change the order of the questions according to the direction that an interview was taking. Although an interview guide was used, the flexibility of a semi-structured format allowed me to add questions if required. In addition, the use of semi-structured interviews allowed me to ask for explanations and clarification when the answers were not clear or to prompt the respondent to elucidate further when necessary. In addition, I was able to establish a style of conversation that was appropriate for a particular participant. Finally, as suggested by Grey (2004), semi-structured interviews gave me opportunities to probe the views and opinions of the participants and to explore new paths that were not previously considered.

During the interviews, I sought to place myself in the shoes of the students in order to help me to interpret the situation from their viewpoint. I was aware that, at the commencement of the interview, the student and I might not share a common understanding and that the student's attitude towards the phenomena was possibly different from my own (McKeowen & Freebody, 1988). It was also acknowledged that I would probably only ever come to a partial understanding of the student's viewpoint of the complex and contradictory perspectives of the situation.

As an active participant in the data collection, my intention was to understand in detail what the students thought of the activity-based teaching strategies that were used. Interview questions were developed to provide insights into whether the activity-based environment affected students' satisfaction in mathematics.

Individual interviews took place with the case study students on a weekly basis for about 20 minutes and were carried out over nine weeks. All interviews were later translated, verbatim, and transcribed.

3.6.5 *Focus-Group Interviews*

Focus-group interviews were used to provide shared understanding from small groups of students (Creswell, 2005).The focus-group interviews aimed to gain shared understanding, as well as to acquire views from specific students in the class about the activity-based strategies.

I considered focus-groups interviews to be appropriate for use in this study because the interactions between the participants were likely to yield more in-depth information. In addition, this type of interview was useful because the amount of time available for collecting information was limited and the individuals were likely to be hesitant in providing data (Creswell, 2005).

As described earlier, the focus-group interviews involved six students, selected from each of five of my classes. During each interview, I asked a small number of general

questions about how the activity-based lesson contributed to the students'
satisfaction in mathematics and elicited responses from all individuals in the group.
Recording was not possible as some students objected to their voices being recorded
and, therefore, I made notes of students' answers to the focus-group interview
questions.

3.6.6   Qualitative Data Analysis

The third research questions asked whether qualitative research methods can be used
to examine how using a range of personally-relevant and concrete activities changed
the learning environment in ways that were perceived to be beneficial by adults who
had experienced failure. Qualitative data, including the use of case studies that were
developed through semi-structured interviews, observations, and focus-group
interviews were used to help to answer the third research question. The case-study
approach made use of qualitative data, which consisted of detailed descriptions of
situations, events, students' interactions and observed behaviour, along with direct
quotations from students about their experiences attitudes, beliefs and thoughts
(Merriam, 1988). The data which were gathered by closely following the progress of
the five case study students helped to provide in-depth insights into whether the
nature of the classroom learning environment and students' satisfaction in
mathematics improved during the use of the activity-based teaching strategies. In
addition, discourse analysis techniques were applied to analyse the semi-structured
interviews and thematic coding was employed to analyse the observations and focus-
group interviews as illustrated in detail below.

3.6.6.1   Thematic Analysis

Thematic analysis was used to identify all of the data that related to the already-
classified patterns, which were then expounded upon. All of the talk that fits under
the specific pattern was identified and placed with the corresponding pattern. For
example, each case-study student expressed his/her reactions to the activity-based
lessons using different phrases. I then gathered sub-themes to obtain a
comprehensive overview of the information and to identify patterns that emerged. As

patterns emerged, I sought feedback from the case study students by interviewing or asking them to give feedback from the transcribed conversations. I often used the case study students' feedback to establish the next questions in the interview.

To build a valid argument, I then returned to the related literature, which allowed me to make inferences from the interviews (Aronson, 1994). It was important to develop a storyline to help the reader to comprehend the process, understanding and motivation of the case-study students. This involved weaving the findings with the literature and formulating themes.

The data analysis was guided by a framework which involved following three stages, suggested by Pope, Ziebland and Mays (2000).

Familiarisation. Once the interviews were transcribed, immersion in the raw data enabled familiarisation with the information collected. A brainstorm of initial key themes was undertaken to allow the grouping of ideas.

Indexing. The interview documents were carefully re-read and every quote that represented an experience, issue, need, conflict or strategy was highlighted and assigned colours. Different colours represented different themes.

Charting. Once all of the interviews were colour-coded, each coloured quote was collated into individual themed documents. The most poignant quotes were included in summary charts. The completed chart then provided distilled summaries of the views, experiences and perceptions of participants. The final stage of the analysis was the inclusion of participant recommendations.

3.6.6.2 Analysing the Observations

In each of the five mathematics classes, I observed the whole class in action. The students were selected for observation based on their willingness to be involved in the study. It should be noted, however, that every student in all of the classes was willing to contribute to this research.

Stories were used to represent a way of thinking and knowing, as recommended by Carter (1993) and Casey (1995), using the researcher's images, understanding and interpretations of the learning environment in each class as the activity-based sessions took place. The stories, along with their interpretation and subsequent commentaries, were used to provide a second layer of representation (Geelan, 1997).

3.6.6.3 Discourse Analysis for Semi-Structured Interviews

Traditionally, language has been regarded as a static entity, composed of component parts, produced by a communicator and decoded by a listener or reader. In contrast, discourse analysis rejects the notion of language as an unambiguous series of signs, arguing that it is engaged, actively, in meaning-making (Wetherell, 2001). Discourse analysts argue that, when people state a belief or express an opinion, they are taking part in a conversation which has a purpose and in which all participants have a stake. In other words, to make sense of what people say, we need to take into account the social context within which they speak (Willig, 2003). This form of analysis examines how specific discourses are formed (Silverman, 2000).

Discourse analysis was used to analyse the interviews in ways that would help me to understand the impact that the activity-based lessons had on the nature of the classroom learning environment and the satisfaction of adult students who had experienced difficulties in learning mathematics. Therefore, it was necessary to examine how students communicated with each other and with the teacher in everyday situations. Discourse analysis involved selecting representative or unique segments of the language used, such as several lines of an interview transcript, and then examining them in detail. Selected text from the interviews for each of the five case-study students was examined to demonstrate how it was organised rhetorically to make claims that were as persuasive as possible, while protecting the researcher from refutation and contradiction (Billig, 1996).

3.7   Chapter Summary

The overarching aim of the present research was to investigate the effectiveness of activity-based teaching strategies in mathematics for UAE college students who had experienced previous failure in learning mathematics. Specifically, I examined whether a modified Arabic version of the CUCEI was valid for assessing classroom environment among tertiary students in the UAE, and whether using activity-based teaching strategies in mathematics was effective in terms of the nature of the classroom learning environment and students' satisfaction. I also investigated whether qualitative research methods could be used to illuminate how using a range of personally-relevant and concrete activities change the learning environment in ways that were perceived to be beneficial by adults who had experienced failure.

The study involved a mixed-method approach that included a survey, interviews and observations of classes. The CUCEI, for assessing students' perceptions of the psychosocial environment at the university and college level, was modified to ensure its suitability for the UAE context. It was administered to 8 classes (84 students), 5 of which (62 students) were exposed to the activity-based lesson throughout the semester, while the other 3 classes (22 students) were exposed to these lessons for only the first 4 weeks of the semester because of their commitment to work placements.

The original seven-scale version of the CUCEI was used to assess students' perceptions of the seven aspects of the learning environment (namely, Individualisation, Involvement, Satisfaction, Personalisation, Students Cohesiveness, Innovation, Task orientation). The original instrument consisted of 49 items, with 7 items in each scale. The questionnaire was translated into Arabic and then back-translated. This prudent process was described in detail in Section 3.5.2. In addition, the questionnaire was pilot tested by administering it to 10 Arab Nationals aged between 16 and 30 years who were also interviewed.

The chapter also provided a description of the units of statistical analysis, as well the statistical analysis approaches that were utilised to answer the research questions.

The validation of the questionnaire used in this research was based on data collected from one college (the Higher Colleges of Technology, HCT) and consisting of 8 classes with a total of 84 students as mentioned earlier.

To check the validity of the modified CUCEI, data collected from administering the questionnaire were analysed by performing principal axis factor analysis with varimax rotation and Kaiser normalisation for the 42 items in six scales (namely, Personalisation, Involvement, Student Cohesiveness Task Orientation, Innovation, and Individualisation) after removal of Satisfaction items. In the factor analysis, the 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. (Note that some of the original 42 items were removed during the factor analysis described in Section 4.3.)

The data from the CUCEI also were subjected to scale internal consistency analysis to investigate the extent to which items in the same scale measure a common construct. The internal consistency reliability, using Cronbach's alpha coefficient, was calculated for each learning environment scale and Satisfaction for two units of analysis, namely, the individual student and the class mean.

To evaluate the effectiveness of the activity teaching strategies, the statistical significance of pretest–posttest changes on the CUCEI were explored using MANOVA with repeated measures. Because the multivariate test yielded significant results overall for the set of dependent variables as a whole using Wilks' lambda criterion, the univariate ANOVA was interpreted separately for each of the five CUCEI scales. Whereas MANOVA was used to investigate the statistical significance of changes between pretest and posttest, effect sizes were used to describe the magnitude, or educational importance, of those differences, as recommended by Thompson (1998) and Cohen (1977). The effect size, which is calculated by dividing the difference between means by the pooled standard deviation, expresses a difference in standard deviation units.

In addition to these quantitative data, I also gathered important qualitative information from five case study students. Interviews with the five students

complemented the quantitative research by providing insights into students' responses to the questionnaire and information about students' reactions to the use of the activities during their mathematics classes.

The qualitative data provided information about the introduction and use of the activity-based teaching strategies that were employed in the UAE. The data were analysed to examine students' interactions while they were experiencing the activities and to triangulate, illuminate and expand students' responses to the questionnaire.

Observations took place in each of those classes where students were exposed to the activity-based lessons. For each of the eight classes, observations of a lesson were carried out three times during each week over the duration of the semester. The observations were focused on students' reactions and attitudes as the activities were introduced in classrooms. These observations assisted me to identify the learning problems and other issues as they arose and helped me to assess how students tackled the use of activities. Observations were recorded as field notes.

The study also involved interviews with students who were involved in the activity lessons. Interviews were held with one student from each of the five classes. These students were chosen purposefully to be interviewed once a week throughout the semester. These interviews were used to obtain students' views of the mathematics activity-based lessons and identified successes and problems during the activities in their classrooms. The interviews were recorded using a digital recorder, with the participants' permission, and then transcribed verbatim.

In addition, focus-group interviews took place at the end of the semester in each of the five classes which involved descriptions of situations, events and students' interactions during the mathematics classes. The focus-group interviews were recorded as field notes.

Discourse analysis and framework analysis were used to analyse the third research question about whether the activity-based lessons influenced the nature of the

learning environment and adult students' satisfaction with mathematics. Thematic analysis was applied through inductive reasoning, with the data being sorted and categorised into the smallest abstract underlying themes. Finally, the results were compared with the findings from the quantitative data to identify similarities and differences.

Chapter 4

DATA ANALYSIS AND RESULTS

4.1   Introduction

As mentioned in Chapter 1, the main purpose of this study was to investigate the effectiveness of using activity-based teaching strategies with adult males in terms of the nature of the classroom learning environment and students' satisfaction. Because valid and reliable tools were needed to evaluate the participating students' perceptions of their mathematics learning environment, another aim of the study was to validate a modified Arabic version of a learning environment questionnaire that can be used with confidence when collecting data to answer the other research questions. In addition, I used qualitative research methods to examine how using a range of personally-relevant and concrete activities changed the learning environment in ways that were perceived to be beneficial by adults who had experienced failure.

Chapter 4 provides analyses and results of the study under the following headings:

- Overview (Section 4.2);
- Reliability and Validity of the CUCEI (Section 4.3);
- Evaluating the Effectiveness of Using Activity-based Teaching Strategies in Mathematics in Terms of Nature of the Classroom Learning Environment and Students' Satisfaction (Section 4.4);
- Use Qualitative Research Methods to Examine How Using Personally-Relevant and Concrete Activities Changed the Learning Environment in Beneficial Ways (4.5);
- Integrating Qualitative and Quantitative Information about Changes in Classroom Environment and Satisfaction (Section 4.6); and
- Summary of Analyses and Results (Section 4.7).

4.2   Overview

This chapter is dedicated to describing the data analysis and reporting the findings based on the survey data and the qualitative data. The survey data were collected from 84 students in 8 classes the Higher Colleges of Technology (HCT) in Abu Dhabi. The instrument was made up initially of seven scales from the College and University Classroom Environment Inventory (CUCEI, Fraser, Treagust & Dennis, 1986) (Personalisation, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation and Individualisation). The questionnaire was modified and translated into Arabic. The qualitative data involved semi-structured interviews, observation and focus-group interviews.

Analysis of data from the survey instrument and the interviews helped to answer the following research questions:

1. Is a modified Arabic version of the CUCEI valid for assessing classroom environment among tertiary students in the UAE?

2. Is the use of the activity-based teaching strategies effective in mathematics in terms of:
    (a)   the nature of the classroom learning environment; and
    (b)   students' satisfaction?

3. Can qualitative research methods be used to examine how using a range of personally-relevant and concrete activities change the learning environment in ways that are perceived to be beneficial by adults who had experienced failure?

The first objective of this study was to provide validity and reliability data for a modified Arabic version of the College and University Classroom Environment Inventory for assessing the mathematics learning environment for adult male students who experienced difficulties learning mathematics in school in Abu Dhabi. Measures of reliability and validity suggest the level of confidence that researchers can have in the results obtained using the instrument. The extent to which a survey

instrument yields consistent data and measures distinct factors gives credibility to the results based on the data obtained using the instrument.

In order to answer Research Question 1, data collected from a sample of 84 students in the HCT were analysed in terms of the factor structure and reliability. The results are reported in Section 4.3 below.

The second objective of this study was to explore whether the activity-based teaching strategies were effective for adult male students in terms of (a) the nature of the classroom learning environment and (b) students' satisfaction. Section 4.4 reports the results for the two parts of this question.

The third research aim of the study was to use qualitative research methods to examine how using a range of personally-relevant and concrete activities changed the learning environment in ways that were perceived to be beneficial by adults who had experienced failure. The results of analysis are reported in Section 4.5.

4.3   Reliability and Validity of the CUCEI

The validity and reliability of the CUCEI are reported using the following structure: background information about the CUCEI questionnaire (Section 4.3.1); factor structure (Section 4.3.2); and internal consistency reliability of the CUCEI (Section 4.3.3).

4.3.1   Background Information about the CUCEI

My study involved modifying the College and University Classroom Environment Inventory (CUCEI) for use in tertiary-level mathematics classroom in the United Arab Emirates and then translating it into Arabic. The original version of the CUCEI had 12 items in each of seven scales and was field tested in Perth, Western Australia with 127 undergraduate and postgraduate students in 10 classes at one multi-purpose tertiary institution (Fraser, Treagust & Dennis, 1986). A refined version (with seven items in each scale) was cross-validated with 30 postgraduate and undergraduate

classes in Australia and 65 postgraduate and undergraduate students in four education classes in America. The final form of the CUCEI has seven scales, namely, Personalisation, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation and Individualisation. Each scale is comprised seven items, making a total of 49 items in all (Fraser, Treagust & Dennis, 1986). Section 4.3.3 identifies some past studies that used CUCEI, whereas Section 2.2.3 in Chapter 2 and Section 3.5.1 in Chapter 3 also discussed the CUCEI in detail.

Modifications were made to the CUCEI to ensure the suitability of its scales for use in my study. The scales of the CUCEI were examined to make certain that they were suitable for examining the effectiveness of using activity-based teaching strategies in mathematics in tertiary-level classrooms in the UAE. Satisfaction was also measured with a modified Arabic version of this scale from the CUCEI, but it was used as attitudinal outcome (rather than a measure of classroom environment) in my study (see discussion in Section 4.3.2). Although all 49 CUCEI items in the seven scales were administered, it was anticipated that some items would be lost in the factor analysis. A description and sample item for each scale of the CUCEI questionnaire can be found in Table 2.2 in Chapter 2.

The CUCEI was originally developed in English. Because all participants involved in my study spoke English as a second language, an Arabic translation was created to ensure that students were able to understand each item. The CUCEI was translated into the Arabic language using back translation, consultation, and collaboration with other people during the process and modification as recommended by Ercikan (1998) and Warwick and Osherson (1973). The modification involved rewriting some of the questions using simpler English words to provide a simpler Arabic translation.

As discussed in Section 3.5.2 in Chapter 3, each item was translated into Arabic by a person fluent in both languages. In this study, it was my sister who was fluent in English and Arabic and who carried out the direct translation. To assess and ensure the quality and equivalence of the translation, a second back translation into English was made by an independent person not familiar with the instrument (my brother).

The instrument had a dual layout with each item in the Arabic version placed beneath the corresponding English item (see Appendix A).

4.3.2   *Factor Structure of CUCEI*

Factor analysis (Kim & Mueller, 1982) is a statistical technique used in data reduction to identify a small number of underlying variables, or factors, that explain most of the variance observed in a much larger number of manifest variables. Using separate data sets (pretest and posttest) for the CUCEI, factor and item analyses were conducted in order to identify faulty items that could be removed to improve the structure and internal consistency reliability. These analyses allow researchers to reduce the number of variables or items contained in an instrument and to focus more closely on components of the area to be studied. If the factor analysis results for an instrument with one sample are consistent with results from previous analyses with other samples, then that gives credibility to that instrument (Pallant, 2001).

In Majeed, Fraser and Aldridge's (2002) study involving the My Class Inventory (MCI), the Satisfaction scale of the MCI was reconceptualised as a student attitudinal outcome instead of as a learning environment scale. I followed the same approach with my factor analysis of CUCEI data. This gave me a measure of student satisfaction for my second research aim and it enabled the factor analysis to work better for the remaining learning environment scales and items.

Data collected from administering the questionnaire were analysed by performing principal axis factor analysis with varimax rotation and Kaiser normalisation for the 42 learning environment items in six scales (namely, Personalisation, Involvement, Student Cohesiveness, Task Orientation, Innovation, and Individualisation) after removal of Satisfaction. The two criteria for the retention of any item were that it must have a factor loading of at least 0.40 with its own scale and less than 0.40 with all other scales. The optimal factor structure was found to occur for a 16-item 4-scale version (4 items per scale) assessing Personalisation, Involvement, Task Orientation and Individualisation (The original Student Cohesiveness and Innovation scales were removed completely.) Table 4.1 shows the factor analysis results. All 16 items have a

factor loading of at least 0.40 on their own scale and less than 0.40 on the other three scales.

Table 4.1. Factor Analysis Results for Learning Environment Scales from Modified CUCEI

Item	Factor Loadings			
	Involvement	Task Orientation	Personalisation	Individualisation
INV9	0.41			
INV23	0.65			
INV37	0.71			
INV44	0.47			
TO5		0.46		
TO12		0.44		
TO33		0.40		
TO47		0.42		
PERS1			0.41	
PERS8			0.61	
PERS15			0.53	
PERS22			0.46	
IND14				0.45
IND21				0.72
IND28				0.48
IND35				0.40
% Variance	33.11	9.44	8.18	7.92
Eigenvalue	5.30	1.27	3.24	2.01

N=84
Factor loadings smaller than 0.40 have been omitted from the table.
Factor analysis involved principal axis factoring with varimax rotation and Kaiser normalisation.

The bottom of Table 4.1 shows the eigenvalue and percentage of variance for each scale of the instrument. The percentage of variance accounted for by different scales ranged from 7.92% to 38.11%, with the total being 58.65%. Also the bottom of Table 4.1 shows that the eigenvalue for different scales ranged from 1.27 to 5.30.

These results are a signal that the factor structure of the revised four-scale version of the CUCEI is clear and repeatable. The combination of factor loadings, eigenvalues and percentages of variance results gives us confidence in the CUCEI for measuring components of the learning environment from the perspective of the students for my sample of college students in the UAE.

4.3.3   *Internal Consistency Reliability of CUCEI*

Internal consistency is commonly used to provide a measure of scale reliability and provide information about the relationship among individual items in the scale. The data from the CUCEI were subjected to scale internal consistency analysis to investigate the extent to which items in the same scale measure a common construct. The internal consistency reliability, using Cronbach's alpha coefficient, was calculated for each learning environment scale and Satisfaction for two units of analysis, namely, the individual student and the class mean.

Reliabilities were calculated separately for pretest and posttest data for the four learning environment scales and for Satisfaction. According to Table 4.2, with the student as the unit of analysis, alpha coefficients for the five scales ranged from 0.61 to 0.75 for the pretest and from 0.64 to 0.79 for the posttest. With the class mean as the unit of analysis, alpha coefficients ranged from 0.61 to 0.77 for the pretest and from 0.63 to 0.82 for the posttest.

Table 4.2.   Internal Consistency Reliability (Cronbach Alpha Coefficient) for Learning Environment and Satisfaction Scales for Modified CUCEI for Two Units of Analysis

Scale	Unit of Analysis	Number of Items	Alpha Reliability	
			Pretest	Posttest
Involvement	Individual	4	0.62	0.64
	Class Mean		0.74	0.63
Task Orientation	Individual	4	0.74	0.79
	Class Mean		0.64	0.82
Personalisation	Individual	4	0.75	0.71
	Class Mean		0.72	0.73
Individualisation	Individual	4	0.61	0.62
	Class Mean		0.77	0.71
Satisfaction	Individual	4	0.65	0.68
	Class Mean		0.64	0.69

N=84

CUCEI scales appear to be valid and reliable when used with adult males in the UAE. The results of this study compare favourably with almost all other research that has involved factor and reliability analyses involving the CUCEI in Australia with undergraduate and postgraduate students (Fraser, Teagust, & Dennis, 1986), in Singapore with primary graduate teacher trainees (Khine & Goh, 2001), in Australia

(Fraser & Treagust 1986), in Australia with preservice teachers (Yarrow, Millwater & Fraser, 1997), in Wellington, New Zealand with secondary students (year 12 and 13) and tertiary students (Logan, Crump, & Rennie, 2006), in Australia with third year dentistry students (Booth, 1997), with first-year and second-year science students at a regional university in the Pacific Islands (Coll, Taylor & Fisher, 2002), in Spain with university students and lecturers in mathematics (Marcelo, 1988), in Spain with secondary school students (Phan, 2008), in the Netherlands with university students (Olani, Hoekstra, Harskamp & Van der Werf, 2011), in the United Stated with preservice teachers (Goyak, 2009), in Malaysia with first year private institute students (Thangiah, 2005), and in Thailand with computer science students in 11 universities (Charik & Fisher, 2008).

However, in both studies that were conducted by Logan, Crump and Rennie, some limitations of the CUCEI emerged. For example, a number of negatively-worded items needed to be omitted to improve the CUCEI's factor structure. Similar limitations arose in my research. In my study, two of the original scales appeared to be problematic for the students, namely, Student Cohesiveness and Innovation. Items 3, 24 and 31 were negatively-worded and reversed-scored items in the Student Cohesiveness scale, whereas Items 6, 13, 34 and 48 were negatively-worded and reversed-scored in the Innovation scale (see Appendix A). Eliminating all items in these two scales enhanced the reliability and factor structure of my modified Arabic version of the CUCEI.

4.4 Evaluating the Effectiveness of Using Activity-based Teaching Strategies in Mathematics in Terms of Nature of the Classroom Learning Environment and Students' Satisfaction

A pretest–posttest design was used to evaluate the effectiveness of using activity-based teaching strategies in terms of changes over a period of three months for my sample of 84 students. Classroom environment was assessed with a modified Arabic version of four scales from the CUCEI (Involvement, Task Orientation, Personalisation and Individualisation). As explained previously in Section 4.3.4, Satisfaction was measured with a modified Arabic version of this scale from the CUCEI.

The statistical significance of pretest–posttest changes was explored using Multivariate Analysis of Variance (MANOVA) with repeated measures. Because the multivariate test yielded significant results overall for the set of five dependent variables using Wilks' lambda criterion, the univariate ANOVA was interpreted separately for each of the five scales. Table 4.3 is devoted to the ANOVA results. The table includes two descriptive statistics: the average item mean and the average item standard deviation for each administration. The average item mean, or the scale mean divided by the number of items in that scale, provides a basis for comparing average scores from scales which could have different numbers of items.

Table 4.3. Average Item Mean and Average Item Standard Deviation for Pretest and Posttest and Pretest–Posttest Difference (Effect Size and ANOVA Results) for each Learning Environment and Satisfaction Scale from the Modified CUCEI

Scale	Average Item Mean		Average Item Standard Deviation		Difference	
	Pretest	Posttest	Pretest	Posttest	Effect Size	F
Involvement	2.82	4.32	0.72	0.51	2.40	3.74**
Task Orientation	2.71	4.34	0.81	0.53	2.38	3.82**
Personalisation	2.58	4.43	0.97	0.46	2.44	4.00**
Individualisation	2.91	3.93	0.75	0.71	1.40	2.89**
Satisfaction	2.47	4.59	0.94	0.45	2.88	4.27**

N=84
**$p<0.01$

Whereas MANOVA was used to investigate the statistical significance of changes between pretest and posttest, effect sizes were used to describe the magnitude, or educational importance, of those differences, as recommended by Thompson (1998) and Cohen (1977). The effect size, which is calculated by dividing the difference between means by the pooled standard deviation, expresses a difference in standard deviation units. Table 4.3 includes the effect sizes.

According to Table 4.3, for each of the five CUCEI scales, pretest–posttest differences were statistically significant ($p<0.01$). Furthermore, the effect size was very large for each scale and ranged from 1.40 standard deviations for Individualisation and 2.88 standard deviations for Satisfaction. These are very large

magnitudes according to Cohen (1977). These large improvements between pretest and posttest support the effectiveness of using the activity-based teaching strategies.

4.5   Use Qualitative Research Methods to Examine How Using Personally-Relevant and Concrete Activities Changed the Learning Environment in Beneficial Ways

In contrast to the reporting of the quantitative part of my study in Section 4.3 and 4.4, this section is devoted to reporting the qualitative aspects of my study. As discussed in Section 3.6, I gathered information from five case study students through individual interviews, observations and focus-group interviews.

In this section, vignettes are presented that describe my students' experiences, how they reacted to the activity-based strategies, and how they interacted with others during the lessons. These vignettes are each followed by commentaries that describe the themes that arose. The composite stories are each based on different Emirati students whom I was lecturing. Over the course of this research and the introduction of the activity-based lessons, there developed between myself and the students a relationship which made students willing to approach me to hold conversations and, in some cases, seek advice with respect to their education and their children's education. The two case study students' journeys are illustrated in detail in the next sections: Sultan's journey (Section 4.5.1) and Saeed's journey (Section 4.5.2).

During my writing, I struggled with the issue of research participants and how to represent them in a socially honest manner in written text. According to Stacy (1988), there is a major difficulty with representing the experiences of others. She argues that, despite the desire to 'engage in egalitarian research', there is a contradiction in the power relationship between the researcher and the subject that always poses a risk of betrayal and manipulation. Denzin's and Lincoln (1994) description of the 'fifth moment' in qualitative research reports issues associated with the crisis of representation and legitimisation and, in a bid to address them, I did two things. First, I ensured that the quotes included in my stories were in fact spoken by the people portrayed. Second, I placed myself within the texts. In doing so, I

acknowledge that these stories and subsequent commentaries are, in fact, my interpretations of situations, experiences and interviews.

I attempted to address the important issue of legitimisation in the writing of the texts in three ways. First, I triangulated data from different sources, following Denzin and Lincoln's (1994, p. 2) advice that:

> ... the use of multiple methods, or triangulation, reflects an attempt to secure an in-depth understanding of the phenomenon in question. Objective reality can never be captured. Triangulation is not a tool or a strategy of validation, but an alternative to validation.

Second, I asked members of the groups involved to read the stories to verify their authenticity. Third, I attempted to represent those whom I studied and their classroom environment using verisimilitude (i.e., to resemble truth or reality).

Based on observations and interviews with the men who were enrolled in the WPR program, I have written two narratives. These stories are followed by a commentary which helps, first, to interpret the story and, second, to investigate the extent to which the story relates to other students in the WPR program.

4.5.1 Sultan's Story

Sultan is 41 years old and has a job in Zayed port. He is a father of four children, the youngest of whom is 8 years of age and the eldest is 16. Sultan is sitting beside me, dressed in Shemaghs or ghutra, the traditional male Emirati headaddress, usually made of goat's wool. Covering his body is a Dishdasha (Khandura), which looks similar to a long shirt that extends from his neck to his toes. Usually Sultan is relaxed in my presence; however, I notice that he appears nervous as he does not stop moving his legs. Early in the interview, it becomes clear that the thought of being recorded makes him nervous; therefore I decide to switch off the voice recorder and use field notes instead.

Sultan joined the Work Readiness Program (WRP) because he would like to get a better job. He is working as a customs officer at the Zayed port, checking imported goods coming from neighbouring countries. Sultan's ambition is to finish the WRP and to start a bachelor degree because this will double his salary, something that he feels will open many doors for him, particularly with respect to finding a managerial job as he would like to be a manager one day.

Sultan tells me that his wife is very proud of him because he is working and studying at the same time and, as a result, she will often encourage him to complete his homework on time. He tells me that his children also are happy that he is studying as he often takes home ideas, related to teaching mathematics, which he has learned at college. It is not unusual for Sultan and his colleagues to approach me at the end of lessons to ask for copies of puzzles or worksheets that we had used and that they could take home for their children.

When asked about how his experiences of mathematics at school, Sultan recalls being reasonably able during his primary years but that he developed an on-going problem with remembering his times tables. He tells me that, as his schooling progressed, the problem became increasingly worse and he was convinced that it was his consistent failure to learn his times tables that was to blame for his failure at school. Sultan blames his inability to learn his times tables on his teachers who, in his opinion, were unable to provide him with any techniques that would help him to memorise basic number facts.

When asked how he would describe his experience of mathematics learning at school, Sultan was happy to discuss his memories. He was in an all-boys school and all the teachers were expatriate (mainly from Egypt and Sudan) and male. He described his classroom experiences during the secondary level being like in a military camp as he was treated in a regimented and very strict way.

When asked about his memories of his mathematics classes, he recalls feeling tense during mathematics lessons and not being able to ask questions of the teacher. He explained how he and his fellow students were required to sit passively and listen to

the teacher talk and explain for the whole lesson. As the teacher explained a topic, he would write on the board and students were expected to copy whatever was on the board. He recalls that, if he wrote too slowly and the teacher ran out of space, he would not wait for him to complete copying but would clean the board, and continue writing. Sultan described lessons of rote learning which involved a lot of memorisation and chanting in which the students would repeat after the teacher, or the teacher would provide a monologue of information with no justification about why or how a problem was solved in a particular way. This method of teaching made Sultan feel like a statue and part of the classroom furniture. To overcome this feeling, he left school altogether. Sultan expressed strongly that he felt that this was the only method and that his teachers did not know any other way of teaching than rote learning, and this was probably a reflection of how they were taught at school.

Sultan recalls that he rarely had the courage to raise his hand to ask questions if he did not understand. He felt that students who asked questions were likely to be insulted or humiliated by the teacher. He describes vividly his memories of being shouted at by the teacher and of being accused of asking a question to which he should have known the answer. Generally, the teacher would accuse a student who asked a question of not listening carefully. He recalls that, in some cases, the teacher would make fun of students who asked questions, making them look stupid in front of the class. It was not uncommon for fights to break out between the student who asked a question and his peers, as it was generally accepted that students laughed or made an insulting comments while the teacher made fun of that student.

One of Sultan's most vivid memories were of the liberal physical punishments that were received by students, particularly for those who failed to submit their homework at the end of the class. Sultan recalls that teachers would usually use a long wooden ruler to strike the students' hands or feet. He recalls one student who was too afraid to open his hands, causing the teacher to hit him on the front his hand with the edge of the ruler rather the flat part. I was physically shocked when Sultan showed me his hands that still bore the long white scar as evidence.

Sultan told me that he felt obliged to leave school in grade 9 at the age of 13 years. He explained that he believed that he would never understand mathematics. Despite these experiences, Sultan felt that knowledge of mathematics was very important and that such knowledge had the potential to help him to get a job. Importantly, Sultan was keen to learn mathematics so that he could make calculations that would be useful to him both at home and at work. Not only was he interested in learning mathematics to help him to calculate but also because he would like to be able to help his children with their homework.

Commentary

Despite his experiences at school, Sultan had chosen to return to study through the Work Readiness Program (WRP). His description of his experiences gave me renewed respect for these men, all of whom had experienced failure at the school level and had chosen to return to education. The school experiences that Sultan described to me were not unusual among the five students whom I had interviewed. Without exception, all of the men who were involved in this study had experienced failure in mathematics at the school level. This commentary identifies the themes that emerged from this story that were common to the stories of other men attending the unit.

Failure in Mathematics

In his story, Sultan explains that he left school at young age, before he had completed secondary education. It would appear that his reason for leaving school early was largely that his classroom experiences made him feel that he could not succeed (particularly in mathematics classes), his fear of mathematics classes and his lack of confidence.

Sultan's constant failure made him nervous in mathematics classes and the liberal physical punishment administered to him as a result of these failures reinforced the notion that he would not succeed. In the story, Sultan describes his fear of asking questions, because of the fear of humiliation. Although the stories described by the

men whom I interviewed were slightly different from Sultan's, they all had the same underlying dread of asking the teacher questions. These students were made to feel that a lack of understanding was the result of being inattentive. If a student asked a question in class, it was not unusual for other students to be derisive or to laugh at him for his lack of knowledge. All of the students whom were interviewed agreed that they were afraid to ask questions because of the consequences, which included being hit, abused or humiliated. One of the students sums up his experience when he said:

> I would have loved mathematics during my secondary level if the teacher was patient enough to answer my questions. In fact I was too afraid to raise my hand and ask about a point that was written on the board. Sometimes I needed to understand how the teacher reached a particular step but the teacher was always very strict. I felt that, if I asked a question, the teacher would make fun of me in front of the other students and my classmates would laugh at me. This would cause friction and hate between me and the rest of the class. [Bandar, aged 22].

Listening and Copying

Sultan explains that his experiences in mathematics classrooms involved, for the most part, listening to the teacher and copying notes from the board. Interviews with other students in the WPR program suggest that Sultan was not alone. For all of the students whom were interviewed, mathematics was viewed with a certain degree of dread and, in many cases, fear. To this end, one of the students commented:

> I hated the subject [mathematics]; I was afraid of mathematics in primary and secondary school because I did not understand it. It got to a stage where I started to fear numbers. [Salem, age 22]

According to the men whom I interviewed, the mathematics classrooms that they experienced at school involved only rote learning. The students whom I interviewed felt that the teaching style did not promote learning in the classroom and that they were not allowed to question the material being taught:

The teacher made us reluctant towards the lesson because he also did not have any strategies to help us to understand the lesson other than his rote learning style. [Ahmed, age 33]

How could I look forward to going to [mathematics] … when I knew I would be sitting like a statue, pretending I understood, feeling tense all of the time and knowing that I could not ask questions of the teacher? I could not think of one positive point when I got up in the morning that would encourage me to be pleased that I have maths that day. I saw the teacher as my enemy. He was a ruthless person who had no mercy. Unfortunately, this was the case from grade 1 until I left school in grade 7. [Rashid, age 38].

Lack of Confidence

When these students enrolled in the WRP program, they were often surprised that they were allowed to contribute to discussions in relation to a variety of topics. Throughout his school years, Sultan lacked confidence in the mathematics classroom. He felt that this affected his performance and self-esteem in other subjects and also when he was not at school. Other students whom I interviewed also admitted to lacking confidence in mathematics. One student said:

When I was at school, I became a person that hated numbers. I got to the stage where I would panic when I saw numbers. [Tariq, age 35]

Another man recollected that students used to look at each other with fear whenever the teacher asked a question. On some occasions, he recalls, no-one would dare to raise his hands to answer the questions, and the teacher would lose his temper and start hitting the ruler on the desk nearest to him. The teacher would then scream at the class, accusing them of not listening or being stupid. Often, on these occasions, the class would be given extra homework as a punishment. Another man recalled that, on one occasion when he did not complete his homework, the teacher asked him to write the multiplication tables (from the two times table to the nine times table) 50 times. He was forced to stay after school, but still could not complete the task. So, as a punishment, the next day, he was beaten with a ruler in front of the class.

During my interview with Sultan, his hate of the mathematics classes that he had encountered during his school years was obvious. This hate of mathematics classes was also clear from the other students whom I interviewed. To this end, Mohammed, aged 35 years, stated: "I hated mathematics due to the class atmosphere and I never thought mathematics can be taught in any other way than the teacher-centred lessons".

Another student, Fuad, explained:

> I disliked mathematics class because I would just listen to the teacher and copy from the board like a robot. I wished I was given the chance to share my idea with my friends by working in a group to carry out a discussion to investigate whether they solved the problem the same way as I did, or whether they might have a simpler and shorter way, which would have given me the opportunity to negotiate and argue about the best method to reach a solution to the given problem. But, of course, I was too anxious to do so, because I know of the consequences" (Fuad, age 40).

There was a range of reasons that led the men in my mathematics classes to return to study. For Sultan, the reasons for returning to study mathematics as an adult were three-fold. The first was related to his desire to obtain a position that was not only better paid but also more highly respected. The second was with respect to helping his children with their mathematics homework. The third was associated with dealing with real-life situations such as being able to perform general mathematics for his personal bills at home and at work. For example, when he has a salary raise, he would have the confidence to try to calculate how much he would be earning at the end of the month if his boss gave a certain percentage raise, or to calculate his overtime hours and add these to the normal hours to find the total amount of pay that he would take home. It would appear that the reasons for electing to return to study were not dissimilar for any of the men whom I interviewed.

Most of these students are fathers to three or four children. They feel financial pressure, for example, when their children ask them for money to register in a course

to improve their language or to treat their children in a private hospital. One student stated that:

> I am responsible for four children and my wife. I want to provide them with everything their friends have. For this reason, I returned to study so I can look for a better job which means better money to satisfy all the needs for my family. [Ali].

Another student stated that:

> My son has been diagnosed with ADHD. He is one of the reasons that encouraged me to come back to study to look for a better job where my salary will be high enough that enable me to save money for him in order to send him for treatments outside the country. [Mubarak].

Essentially Sultan was determined to learn mathematics so that he could perform basic mathematical calculations. Of concern to him was learning the skills to be able to perform tasks such as calculating how much change a cashier would give him back, to calculate his annual salary, especially when he is given a salary rise, or to calculate the best deal for his family airline tickets when he finds competitive offers in the newspaper. Sultan stated that:

> I usually purchase airlines tickets for myself and my family without comparing the best offers when I read newspapers or when I pass by a travel agent as I did not know how to calculate percentages. I feel as if I was a blind person.

It was noteable that the desire that many of these men had to learn mathematics was also driven by the desire to be able to help their children with their homework so that their children would not be punished and fall behind in their studies as a result of not submitting assignments on time. The other reason that encouraged students to return to study to help their children was that, if they are not able to support them with their school work, they would need a private tutor which they could not afford. The most

outstanding reason that students claimed was to attract their children to the new styles and strategies of learning mathematics. One of the men stated that:

> I came back to do study so that I can help to teach my little brother and sister, so that they will be attracted to mathematics. I use many of the activities that I have been taught here in teaching my brother and sister because I do not want them to have the same distorted picture of mathematics that I had before joining this mathematics class. [Bander].

Another student stated:

> My son used to have many detentions and punishments at school because he could not do the   homework which I tried to help him with before registering in the WRP. Since I started supporting him, his academic level rise in mathematics and I receive less negative comments from his teacher. [Khalid].

In some cases, the men whom were interviewed explained that they did not want their own failure in mathematics to happen to their children. In another case, a student whom I interviewed said that he did not want to feel inadequate and be seen as being incapable or lacking in know-how in the eyes of his children. Past research has indicated that this is not an uncommon phenomenon as Swain (2005) describes that one of the major reason why people come to mathematics classes is to help their children. This role of being teacher is, according to Swain (2005), not only an important element of being a parent by helping to establish closer bonds, but it also helps adults with their own learning by making them reflect on their own work in a particular way.

The mathematics lessons that these men had experienced had led many of them to hate mathematics because they did not feel safe. To this end, one student stated during the observation:

> I used to run away from school when I had mathematics lesson because one day the teacher broke my elbow with that long wooden ruler, just because I asked to my peer friend for help. [Faisal, age 32].

All of the men who attended the Work Readiness Program had experienced failure and nothing but the teacher-centred approach described above. Without exception, all of these men had also experienced physical punishment at one time or another. These experiences with mathematics had led to a range of reactions and, when the men first attended my classes, there was a range of reactions to the lessons that I taught. For the first time in their lives, these men were exposed to activity-based lessons in which they were able to become actively engaged with the materials, collaborate with each other on activities and discuss their problems with their peers. This following story, entitled 'Saeed's story', tells of his role in an activity that took place nine weeks after the program had started. The commentary that follows explains how my mathematics classes helped to facilitate this journey.

4.5.2   Saeed's Story

As I neared the classroom, Saeed, one of my students, asks "How do you want the desks to be arranged today Miss". Over the past few weeks, the students have become familiar with the routine of rearranging the desks as the first task of each lesson. Each time we meet, I arrange them slightly differently, depending on the activity that I have planned for that day. The last lesson was arranged in pairs and the men had helped me to join every second desk together. The lesson before, we had an activity that involved group work and we had joined every four desks together.

As I enter the room, the desks, as always, are arranged in rows, facing the front of the classroom, each desk separate from the next. I recall that, when I first started to rearrange the desks, the teachers who used the room after me would complain if the arrangement was not returned to the traditional rows. I am keenly aware that I am the only lecturer at the college who does not use the more traditional classroom setting. Therefore, the first and last five minutes of each mathematics lesson is allocated to desk arrangement.

Once in the room, I tell Saeed and three of his colleagues who were all waiting at the door that, for today's lesson, I would need the desks to be arranged into groups of

three. They enter the room with me, talking excitedly to each other as they decide how they will arrange the desks into groups of three for today's lesson.

The remainder of the class, a total of nine men aged between 19–31 years arrive and get seated. I started the lesson by greeting the students and asked them how their day was. I noticed that, since I walked into the classroom, most of the students' eyes were directed to the transparent plastic bag that was in my hand which consisted of the dice. To attract their attention, I then asked the class if they know a place in Abu Dhabi where I can purchase the dice on their own without having to buy the board game so I can make use of the dice only. I told them that I collected the dice in the bag that was in my hand from my children. I noticed that every student stared immediately discussing with the person sitting next to them about how to help me. Saeed suggested that he is willing to go to a carpenter and ask him to make as many dice as I want. I told him that this was a great idea, but I advised Saeed that there was no need to go through all that. Another student suggested that I try to go to a particular shop where he described its location to me and see if they sell the dice on their own. Another student from the back of the class shouted out that he can order them for me from outside the country. This was how I started the lesson where students started discussing among themselves so that they can help me. I have assured the class that I have enough dice for them to play the activity that I will be introducing shortly, but it was not enough for the other classes which consisted of larger numbers of students.

The men, sitting in their groups, listened to my introduction. It has become routine that the first 10 minutes of each lesson involves introducing the students to the activity that will take place. This lesson was no different and I explained the rules of the game, designed to help them to memorise their timetables. We had done much work over the past weeks on multiplication, addition (using exchange), and mathematics vocabulary and this game was designed to help them to consolidate their understandings. I announced to the class that today's lesson would involve a dice game and instructed the students that they would be working in groups of threes. Each player in a group would be given a number from one to three, with player three being responsible for recording the scores for players one and two and for adding

the scores at the end. Players one and two would take turns to roll the die and to find the product of the numbers thrown. At the end of the game (after 10 throw each), the third player would add the scores.

I requested that Saeed and his friend (Khalifa) come to my desk so that the game could be demonstrated to the remainder of the class. The three of us sat around my desk, and I asked the remaining men to stand around the outside so that they could watch to see the game in action. I gave each of us a number, with Saeed being player one, Khalfan player two, and myself player three. I give Saeed the two dice and instruct him to roll them. As they stop rolling, Saeed calls out 'five times seven'. I remind him that, in order to move, he needs to provide the product for the two numbers. More quietly he says 'five by seven'. He is looking down and the furrow in his brow indicates that he is thinking about the answer. As he was thinking, the students who are standing around the outside become animated and start to call out the answer, some of which were wrong and some right. They are trying to help Saeed, with some arguing with others about whose answer is correct. Saeed, with the help of his fingers, tries to add 5 seven times, and then he was convinced that the students who called out 35 were the ones who were correct. The audience around him started to clap for him once he told me the answer. I recorded the numbers and its product in the sheet that I was responsible for as the duty of the third player. Then I asked Khalifa, who was player two, to roll the dice this time and tell me the numbers and the product so I can record it in the sheet provided. As he rolled the dice, they stopped rolling, Khalifa stares at the dice and says "three multiplied by 7". He next looked at his friend with a smile and asked them to give him a chance before they start calling out the answer. I heard Khalifa adding 7 to 14 as he knew that 7+7=14 and he only needs to add another 7, so he called out 21 with great excitement looking at me and then at his friends for confirmation. Once confirmed, one of his friends slapped his shoulder playfully while others clapped.

We repeated the same operation again and, after three turns, I added Saeed's and Khalif's score. I explained that, so far, Saeed was winning because his score is higher than Khalifa's. I explained that, at the end of the game, players one and two should check whether the third player added their score correctly.

Students came to my desk to collect the pair of dice and the scoring sheet and they put themselves in a group of three. The noise level went up immediately with the sound of rolling dice and students talking as they found the product. Occasionally, a student would shout a question to me over the noise such as "Miss, isn't 6x7=42?"

Saeed was in a group with Khalifa and Mussalam. At the beginning of the game, I noted that, when Saeed rolled 9x8 he wrote out the 9 table to work out the answer. He was determined to find the correct product even though his colleagues had told him the answer. He was determined to achieve it himself and not to rely on his colleagues. During the game, as Saeed's friend was adding the scores, Saeed wanted to make sure his friend was adding his score correctly, so he started arguing in a fun way with his friend to check whether he is adding correctly. Saeed was trying to remember how to add vertically and asked me to illustrate how to add two-digit numbers. As I started to add vertically, I realised the other groups were interested to know how to do the carry operation. Those students who were rolling the dice, stopped to do so, and students who were negotiating stopped as well. The class was quiet while I was writing on the board. Saeed copied what I wrote on the board in his maths copybook like the rest of the students in the class. He asked me to teach the class during next lesson how to subtract two or three digits numbers with zero in them as he never understood it at school. I agreed and told them to remind me to illustrate that as our warm-up exercise for next lesson. When the class heard Saeed's question, they supported his idea and everyone was back playing the game and continued at the stage they were at. Saeed was very supportive as he started to show the third player how to add vertically, and I noticed he was very patient as his colleague was making a careless mistake while adding. Towards the end of lesson, I started to notice that Saeed began to ignore the sheet he wrote which included, for example, the 9 times tables and other times tables and he started to look at them only when he wanted to make sure that his answer is correct. Saeed looked confident and more relaxed than he was at the beginning of the game.

Commentary

Like Sultan, Saeed joined the WRP program so that he could upgrade his qualifications and get a better job. Saeed also described similar experiences in school to Sultan, although he did explain that he had a private tutor during his secondary school years, which made his life a little easier as he did not need to ask the teacher any questions. Unfortunately, despite the tutor, Saeed still failed mathematics at the end of the year.

His experiences at school had led him to dread mathematics and this was evident when he first started the program. He would never raise his hand when I asked a question, would give up easily when he did not achieve the right answer during classwork, would not ask me for help unless I approached him, and would seem nervous and irritated (e.g. he was shaking his legs throughout).

The story starts with the arrangement of the desks at the beginning of class. Although this had become somewhat routine for the class members, it is interesting to note that these students had never experienced anything other than traditional teacher-centred methods both at school and in other subjects at the college. As always, the reaction of the students to the activity was one of excitement and enthusiasm. During the interviews conducted with these men, they were keen to express that they looked forward to mathematics lessons because they knew that they would do something different from the traditional teaching that they had experienced.

Over the nine weeks that I had been teaching Saeed, I observed changes from a quiet student who was reluctant to ask questions or to contribute in class discussions to one of the most enthusiastic and, at times, boisterous class members. His demeanour, coupled with his responses to interview questions, indicated that his self-esteem (particularly with respect to completing mathematics tasks) and confidence had improved enormously since the start of the program. Analyses of the interviews with the students helped to distil the following themes that explain these changes in Saeed: positive teacher–student relationships and the use of collaborative learning.

Saeed's story suggests good rapport between the students and the teacher; one of mutual respect and openness. Most of Saeed's recollections were of secondary school. He cast his mind back to feeling nervous and in fear in case he was asked a question by the teacher and he got it wrong or did not know the answer. He always knew that the consequence would be putting out his hands to be hit with a long wooden ruler.

An important starting point with these men, all of whom had experienced abuse from their teachers, was to cultivate a positive relationship between them and myself. I felt that it was important that I established a degree of trust and mutual respect, which I did in a number of ways. Outside the classroom, I sometimes had breakfast with them, providing a relaxed atmosphere in which they could confide in me. I generated a positive relationship with my students during the course as being approachable, encouraging and helpful.

A number of students were interested in the board games that I brought to class, and approached me to ask if I could purchase the same games for their children as most of them live outside Abu Dhabi. They handed me the required amount of money and they were pleased that I had no objection to purchasing the games for them.

On many occasions, students walked with me to the college cafeteria during breakfast or lunch hour and sat with me as they asked for advice regarding their children and how they could help them in certain educational aspects and how they could improve their education.

Also students would approach me whenever we had a puzzle worksheet to ask for a few copies for their children and for themselves to revise the topic that they learned through the puzzle worksheet. I usually gave it to them but, when I did not have enough copies. I asked them to come at a later time to my office to collect the required copies.

Teachers, either inside the classroom or outside the classroom, exert a great deal of influence on establishing a good quality of teacher–student relationship (Barry & King, 1999). In such an emotional climate, the most important ingredients of effective teaching for teachers to build up were to maintain and improve a positive relationship with students and to provide materials to cater for students' needs and interests (Jones & Jones, 2004). Students' deeper understanding can be achieved through dialogue and collaboration with their peers and their teachers (Biggs, 1999).

In one instance, Mubarak wanted to take his son to be scanned for ADHD in one of Abu Dhabi medical centres, but Mubarak had no idea where to take him. He approached me for help. I called friends and got hold of the number of the best medical centre in Abu Dhabi to give to Mubarak. During the week after, I had to sit with Mubarak at the end of the college day to fill in an application form which was in English for his 8 year-old son who was being scanned for ADHD in a psychiatric centre in Abu Dhabi. The process of filling in the application form took 30–45 minutes because I had to read the questions, translate them verbally into Arabic, give time for Mubarak to think about what answer he would like me to write, and write it down.

According to Barry and King (1999), how good the teacher's relationship with students is largely decided by the quantity and quality of contact made with each student as an individual. A good teacher treats students as individuals, has a loving heart and is warm to his/her students.

On one occasion, students wanted me to train them for the diploma course entrance test questions because they intended to apply for the diploma course after achieving their WRP. So, I approached the lecturer involved in setting the questions and he provided me with practice papers for the last six years. I managed to photocopy the past papers and give them out to the students, who were interested in perusing the Diploma course and answering questions at home. I assigned sessions after college hours for them to explain the questions with which they needed help and to correct the rest of the questions.

School connection is the belief by students that adults in the school care about their learning and about them as individuals. Students are more likely to succeed when they feel connected to school. Critical requirements for feeling connected include high academic rigour and expectations coupled with support for learning, positive teacher–student relationships, and physical and emotional safety (Blum, 2005).

Developing a Supportive Environment through Collaboration

Saeed's story describes an activity in which the students were working together. As they played the game, the students were talking to each other, asking questions and helping each other work out the problem. I tried to ensure that collaborative activities were part of every lesson that I taught. By using activities that involved students collaborating together, they were encouraged to interact and communicate. This was in strict contrast to anything that they had experienced before in their past education. As one of the students stated: "I felt that the teacher looked at me as a piece of furniture not as a human being who has feelings" (Abdulla, age 30 years). According to Barry and King (1999), students are humans first and learners second. The university should not only be an institution for teachers to enhance students' learning, but also an interactive community of human beings.

This interaction through collaboration helped in a number of ways. Although it is widely reported that group work has many benefits (e.g. Steinke, 2008), it was heartening to watch its benefits being played out in this class of adult males. According to the men whom I interviewed, it was helpful to work in groups as it forced them to justify their reasoning to others and helped to pinpoint areas of misunderstanding and confusion. They also felt that working in groups was more fun:

> I am enthusiastic to solve the problems that are given and to air my view of
> the steps I took to achieve the answer. Also I am eager to find out whether
> my friends had a simpler method that I might use in solving the problem in
> the future. This is the first time I have been given the opportunity to share

my ideas about how to answer problems and to support my friends. I enjoy

maths classes now. [Husain].

As a result of the collaborative learning, the students in my mathematics classrooms developed a community in which they were able to provide emotional and intellectual support for each other. This collaborative work promoted discussions of alternative strategies, making mathematics learning an engaging, interactive learning process, with the teacher not necessarily the source of all information as recommended by (Steinke, 2008):

> The double lesson passed by very quickly as I was not working on my own.
> The idea of working in group encouraged me to know other members in the
> class and investigate other strategies with which the problem can be solved
> without having to call the teacher for help [Ahmed].

The use of activities that encouraged collaboration would appear to have had an impact on students' self-esteem, confidence and motivation. One student, Salem (age 22 years), who was helping his friend about how to solve a puzzle, said:

> I never thought I would experience helping someone else with mathematics.
> When I was at school, I was afraid of numbers and I would panic and
> become nervous if I saw them, but now these feelings have disappeared. I
> think the reason for that is the praise that I get from you [the teacher]. The
> discussion that takes place every lesson motivates me. Being engaged in the
> learning process when we work in pairs during an activity helps me to learn
> from others.

It would appear that the nine weeks of applying the activity-based teaching strategies made a positive impression on the students. All of the students stated that they would wish for their children to experience what they had experienced during the nine weeks of varied, useful, interesting, enthusiastic and motivating activities.

4.6 Integrating Qualitative and Quantitative Information about Changes in Classroom Environment and Satisfaction

The quantitative results, reported in Sections 4.3 and 4.4, include large pre–post differences for the four learning environment scales (Involvement, Task Orientation, Personalisation and Individualisation) and the Satisfaction scale. Section 4.5 provided analysis of the qualitative data which supports the results based on the quantitative data. Because learning environment research is enhanced by using mixed methods, combining quantitative and qualitative data is recommended by many in the field (Aldridge & Fraser, 2000; Fraser & Tobin, 1991; Tobin & Fraser, 1998). To allow deeper understanding of the learning environment in my research, quantitative data were supplemented by using classroom observations and interviews. Analyses of the information gathered during the observations and interviews helped to illuminate the large and statistically significant pre–post differences for each CUCEI scale.

In summary, the qualitative data collected through interviews or focus groups were used to support the quantitative data and provide richer insight into the data. Interviews, observations and focus groups have proven extremely useful in past learning environment research (Aldridge, Fraser, & Huang, 1999; Mink & Fraser, 2005; Spinner & Fraser, 2005). Qualitative data complemented the quantitative findings in providing new explanations and insights. In Chapter 3, Section 3.5.2 explained in detail the methods that were used in collecting the qualitative data in my study.

In the next subsections, I attempt to explain and embellish the results for each questionnaire scale using insights that were revealed during the observations and interviews.

4.6.1 Involvement

This scale can be used to assess the extent to which adult students participate actively and attentively in class discussion and have attentive interest in the activity-based teaching strategies. The Involvement scale also assumes that student

negotiation is a vital aspect of the learning process because it provides opportunities for students to participate in class discussions, exchange ideas and understand what they learn with one another, rather than just taking notes passively (Taylor & Campbell-Williams, 1993).

According to Table 4.3, the large change in Involvement was 2.40 standard deviations between pretest and posttest. Classroom observations that were undertaken during the activity-based classes, as described in Saeed's story, indicated that students were actively involved as they solved the puzzles and played the games. During these activities, the students were involved in discussions with their colleagues and exchanged their thoughts throughout the sessions. For example, as described in Saeed's story, one of the students, Husain, was enthusiastic about solving the problem posed in the activity and finding out from his peers whether they had a simpler or faster way to find the answer. One of the students who was interviewed observed that "being engaged in the learning process when we work in pairs or in groups during an activity helps me to learn from others and to become closer to other members of the class". These finding were supported by Aldridge and Fraser (2008), who reported that social acceptance by peers and the need to have friends are important aspects that can affect students' learning.

When students in my class were asked to express their opinion about the level of involvement during the activity-based sessions, they all agreed that they were given opportunities to discuss their ideas and that they considered this to be important. The students whom were interviewed generally felt that their comments were respected by their peers and that the variety of activities enabled students to be more engaged in the learning process. According to Montague (2004), class discussions lead to effective learning as they have the potential to enhance students' goal setting, self-monitoring, self-questioning and self-checking.

Another student remarked: "When the teacher asked for my opinion, it seemed unusual at first because I was never involved in dialogue when I was at school. It is a wonderful feeling when I explained my ideas to the whole class and other learners asked me questions about how I solved the problem." Of note is that one student

commented that, "when other students admired my ideas and suggestions, it built up my confidence and now I am no longer afraid of numbers". According to Eldred et al. (2005), there is a growing body of evidence that suggests that confidence and self-esteem have important roles to play in the learning context. In this respect, the activity-based mathematics classes were successful in that, as the teacher, I was able to act as a facilitator who instructed and encouraged class discussion, as recommended by Reyes and Vallone (2008).

4.6.2 Task Orientation

The Task Orientation scale assesses the extent to which class activities are clear and well organised. An important consideration of activity-based sessions of any kind is to ensure that the instructions are clear and concise and, where possible, involve a step-by-step outline of what is required. In addition, it needs to be made clear to students what needs to be accomplished by the end of the session (Fogarty, 1997).

For Task Orientation, Table 4.3 revealed a large and statistically significant pretest–posttest change of 2.38 standard deviations. The students whom were interviewed agreed that the activity was usually clear and that they knew what to do once the teacher had given the instructions. In most cases, the step-by-step procedures, such as rehearsing a game, made the goals and procedures of the activity clear. One of the students commented, "When we finished the warm-up exercise, we knew exactly what would follow next, which were the clear and carefully planned instructions of the activity of that particular lesson". Another student commented: "Although we all felt that the teacher was approachable and that we felt comfortable about seeking help if we encountered a problem during the activity, the instructions were usually clear and the activities were carefully planned according to the topic that was to be covered in that week. Therefore we knew exactly what had to be done in our mathematics classes." All of the students whom were interviewed agreed that they were always on task as they felt that the activities were useful and helped them to learn mathematics through collecting information, writing down facts and hypotheses, and discussing them with their peers or with their teacher.

The careful and punctual organisation of lessons also served to encourage students to be more organised themselves. When the students were asked to comment on the level of organisation, one of the students said that he made sure that he arrived before the teacher because he knew that the lesson is divided into intervals and it always started on time. This student said, "If I arrive late to my mathematics class, I will miss out on the warm-up exercise which is usually relevant to the activity. I give value to every minute of my maths lesson now." Another student remarked, "If I miss out on the instruction part of the activity, I know that I will distract my friends who are on track and focused on working on the activity. I consider my mathematics classes are always organised."

4.6.3   Personalisation

This scale assesses students' perceptions of the emphasis on opportunities for individual students to interact with the teacher and the teachers' concern for the students' personal welfare. In the Personalisation scale, it is assumed that the teacher plays a significant role in creating a relaxed learning environment during the learning process by providing mutual respect and trust with the students as recommended by Chodkiewicz, Widin and Yasukawa (2010). According to Perry (2006), the relationship that educators establish between themselves and the students and between students in the class is important in creating the best learning environment. Furthermore, Aldridge and Fraser (2008) claimed that a supportive learning environment permits students to make mistakes without the risk of being ridiculed.

For the Personalisation scale, the significant improvement in the mean score between pretest and posttest was 2.44 standard deviations (see Table 4.3). During mathematics classes, I went out of my way to establish a good student–teacher relationship. Interviews with the students indicated that they felt that I would help them whenever they required my consultation about issues concerning either the activities. One of the students commented, "One of the factors that made me understand and enjoy the activities is that I felt that you were approachable and considerate as you were going around the class checking, praising and supporting the students who were behind in the activity." Another student commented:

I feel relaxed when I see you moving around the classroom. You stopped to talk to me even if I did not put my hand up to request your help. This gave me the feeling that you were interested in supporting and that you considered my feelings. If I needed to ask a question, I never was accused of not listening and I never felt humiliated in front of the class.

My experiences of the activity-based sessions and the interviews with students indicated that, by encouraging students to consult with me about their educational issues and about their children's future, the students felt that I cared about them on a personal level and that I was friendly and approachable. Benenett and Carré (2000) considers that teachers' love and concern for students is more important that other teaching aspects. According to Aldridge and Fraser (2008), it is of paramount importance that the teacher creates a supportive learning environment for students and provides the physical and social conditions for effective learning. Also, Hijzen, Boekaerts and Vedder (2007) stated that the relationship between teachers with their students is essential to a student's success and for creating a positive learning environment.

4.6.4 Individualisation

This scale involves the extent to which students are treated differently according to abilities, interests or rates of working. Like the other scales, this scale showed a large and positive pre–post difference of 1.40 standard deviations (see Table 4.3). It would appear that, for the students whom were interviewed, there was an element of surprise when they were given choices during activities. For example, during one of the activities, students were surprised to be given the choice of which newspaper percentage problem to work on. One student commented, "The activity was fun because I chose to calculate what I am usually interested in, which is the family airline fare, while the person next to me was interested in calculating the discount that he would get from a store at which he shops. Another student remarked, "I feel that students are relaxed and that, in general, the atmosphere in the classroom is happy, meaningful and productive. Every student is busy solving the newspaper problem that he chose to tackle. In other subjects at the college, we are exposed to textbooks but, in mathematics classes, we are exposed to activities." Research supports the notion that,

if students are actively involved in a learning activity such as the newspaper problem, then it is likely that learning will be meaningful to students (Kangas, 2010; Kember, Ho & Hong, 2010).

During the activity-based classes, I considered it important to find ways to help students to overcome their fears, as recommended by Gerber, Ginsberg and Reiff (1992). To do this, I was careful to ensure that students were able to work at their own pace and to use strategies that worked for them. One student remarked, "Once we were given the directions, I often had the opportunity to choose the activity that I was interested in. I could work at my own pace and it didn't matter whether I finished before or after my friends, as we all had different tasks. When I finished early, I had the enthusiasm to join my colleague, who was in my group, to work with him to help him to accomplish his task." Another student commented:

> In my opinion, the teaching approaches in this mathematics class permit me
> to proceed with the activity at my own pace without having the fear of not
> finishing the task the same time as my friends which used to lead to having
> the teacher shouting or humiliating me in front of the class when I was at
> school.

4.6.5   Satisfaction

This scale assesses the extent to which students enjoy their mathematics classes. Because one of the objectives of the present study was to investigate the effectiveness of using activity-based teaching strategies in terms of students' satisfaction, I was interested in examining whether using activity-based classes would improve student satisfaction. The pre–post change in the Satisfaction scale was very large and positive (2.88 standard deviations) as shown in Table 4.3.

The students whom were interviewed generally felt that they enjoyed the activity-based mathematics classes. Students explained that, after experiencing the activity-based teaching strategies, they had gone from having a fear of mathematics to enjoying mathematics more than any of the other subjects. The students all put this

down to being involved in activities rather than listening to the teacher, solving problems from a textbook or copying from the board.

One student commented:

> I look forward to coming to my mathematics classes now because I know that the lesson will be interesting and I understand the topic. Whereas before, I used to either run away from school when I had mathematics in my timetable or, when I attended the lesson, I would put my head on the desk until the period finishes because I was bored with the teacher just explaining on the board for 50 minutes.

According to another student, "I always arrive early for my mathematics class now because I know there will be a new interesting idea that I will take home to my children. We will often play the game together or solve the problems for fun. My children usually ask for second rounds or for another puzzle." Another stated that "the activities helped me to understand mathematics while I had fun". All of the students whom were interviewed were satisfied with the activity-based classes and were keen to point out that the activities were useful in their daily lives. One student remarked, "I now consider mathematics to be a very interesting subject because, after experiencing the activities in class, I feel motivated and encouraged to learn more." According to Paraskeva, Mysirlaki and Papagianni (2010, p. 499), the use of games is a "fun, engaging, motivating, interesting and encouraging way" of teaching. In addition, Kim (1995) claimed that it is a common misconception that all learning should be serious in nature and that, if one is having fun, then it is not really learning.

As mentioned earlier, I used a mixed-method approach that involved a questionnaire, observations and interviews to investigate the impact of activity-based teaching strategies on students' classroom learning environments and satisfaction. The results suggested that the activity-based teaching strategies had a positive impact on students' satisfaction towards mathematics and their perceptions of several important aspects of the classroom environment. My findings suggested that, during exposure to the activity-based teaching strategies, students experienced a substantial

improvement in Involvement, Task Orientation, Personalisation, Individualisation and Satisfaction.

Narratives of students experiencing different teaching strategies suggested that, with the introduction of a variety of mathematics activities in the classroom, students were given opportunities to interact with each other and to explain and compare their solutions with their group peers. When the information obtained from interviews with students was analysed, I found consistency between the qualitative data and the pre–post differences that were large and statistically significant for all scales (Involvement, Task Orientation, Personalisation, Individualisation and Satisfaction).

4.7   Summary of Analyses and Results

The present study's results support the effectiveness of teaching strategies that engage college students who had experienced childhood difficulties with learning mathematics in the United Arab Emirates (UAE). The study was unique because it involved multiple research methods to achieve a better understanding about changes in different aspects of classroom environment and students' satisfaction when those teaching methods were utilised.

In order to answer Research Question 1, data collected from my sample of 84 adult male students in the HCT were statistically analysed to determine the validity and reliability of the CUCEI questionnaire, in terms of its factor structure and internal consistency reliability. Factor analysis results for the learning environment scales from a modified version of the CUCEI with 16 items were revealed that all items had a factor loading of at least 0.40 on their own scale and less than 0.40 on the other three scales. The total proportion of variance accounted for was 58.65%, with the variance for the different scales ranging from 7.92% to 38.11%. The eigenvalue for different scales ranged from 1.27 to 5.30.

Cronbach's alpha coefficient for each of the learning environment scales and Satisfaction ranged from 0.61 to 0.75 for the pretest and from 0.64 to 0.79 for the posttest with the student as the unit of analysis. With the class mean as the unit of

analysis, alpha coefficients ranged from 0.61 to 0.77 for the pretest and from 0.63 to 0.82 for the posttest.

In order to answer the second research question concerning whether the activity-based teaching strategies were effective for adult male students in terms of the nature of the classroom learning environment and student satisfaction, MANOVA was used to examine the statistical significance of the pretest–posttest changes. Additionally, effect sizes were used to describe the magnitude of pre–post changes. Very large magnitudes for pre–post differences ranged from 1.40 standard deviations for Individualisation to 2.88 standard deviations for Satisfaction. Also changes were statistically significant for all scales.

Research Question 3 focused on whether the use of qualitative research methods could illuminate how using a range of personally-relevant and concrete activities changed the learning environment in ways that were perceived to be beneficial by adults who had experienced failure. The generation and analysis of data collected using classroom observations, interviews with participants, and narrative stories allowed me to explore students' experiences, identify how students reacted to the activity-based strategies and to make meaningful interpretations about how students interacted with each other during the lessons. Based on the narratives, students were enthusiastic about coming to the mathematics classroom, they found the activities useful for their everyday life and for their children, the activities motivated them and raised their self-esteem, they no longer had the fear that they had previously towards mathematics, they were relaxed about approaching me for assistance, they found the activities interesting, they understood the topic through experiencing the activities, and they enjoyed the lessons which led to them to being very satisfied with each mathematics lesson. Overall, the qualitative data were consistent with the large pre–post differences found for each learning environment and satisfaction scale.

Chapter 5

DISCUSSION AND CONCLUSION

5.1   Introduction

Over 40 years ago, learning environment research was initiated and it still is undergoing strong progress and development (Fraser, 2012). However, no previous studies have involved the effectiveness of activity-based teaching strategies with adult male students in the UAE in terms of the nature of the classroom learning environment and student satisfaction.

This chapter provides a summary of my thesis in Section 5.2. Section 5.3 focuses on the major findings of my research, while Section 5.4 focuses on limitations and suggestions for future research. The significance and implications of the study are discussed in Section 5.5. The chapter ends with some concluding thoughts and a concluding summary in Section 5.6.

5.2   Summary of Thesis

My research represents a unique investigation of the learning environments of adult male students in the Higher Colleges of Technology (HCT) in the United Arab Emirates. Three questions shaped the research:

1. Is a modified Arabic version of the CUCEI valid for assessing classroom environment among tertiary students in the UAE?

2. Are the activity-based teaching strategies effective in terms of:
   (a) the nature of the classroom learning environment; and
   (b) students' satisfaction?

3. Can the qualitative research methods be used to examine how using a range of personally-relevant and concrete activities changed the learning environment in ways that were perceived to be beneficial by adults who had experienced failure?

A major contribution of this study is that the College and University Classroom Environment Inventory (CUCEI) was translated into the Arabic language and validated. The modified Arabic CUCEI has 16 items 4 in scales version (4 items per scale) assessing four learning environments dimensions that are important in mathematics classrooms, namely, Involvement, Task Orientation, Personalisation and Individualisation. As well, it has a Satisfaction scale (see Appendix A).

Chapter 1 began with a description of the adult male students in the Higher Colleges of Technology (HCT) who were attending the Work Readiness Program (WRP) after they had failed school when they were in grade nine. WRP students had experienced many difficulties grasping basic principles of mathematics. Therefore, I was curious to investigate the effectiveness of a modification in the methodology to teaching and learning methods aimed at helping these adult males to attain the skills that they were lacking, perceive their learning environment differently and improve their satisfaction with mathematics. I investigated how the use of different activities could be beneficial for these adults who experienced difficulties with learning mathematics in the past that resulted in them failing school at an early age.

Chapter 2 was a review of the related literature and described the instruments used in gathering data in past research. In Section 2.2, I described the early work and history of learning environment research, starting from the 1960s with the research of Walberg and Moos (Moos, 1974a; Walberg & Anderson, 1968) and leading to the many recent applications of learning environment research (Fraser, 2007, 2012). The section also focused on the development, validity and reliability of numerous learning environment instruments (LEI, CES, ICEQ, CUCEI, MCI, QTI, CLES, SLEI and WIHIC) that have historical and/or contemporary significance. The Learning Environment Inventory (LEI, Walberg & Anderson, 1968) and the Classroom Environment Scale (CES, Moos & Trickett, 1974) are the two earliest instruments. The Individualised Classroom Environment Questionnaire (ICEQ,

Rentoul & Fraser, 1979), the College and University Classroom Environment Questionnaire (CUCEI, Fraser & Treagust, 1986), the Constructivist Learning Environment Survey (CLES, Taylor, Fraser, & Fisher, 1997) and the Science Laboratory Environment Inventory (SLEI, Fraser, Giddings, & McRobbie, 1992) were developed for more specialised environments. The questionnaire that was developed for children in the elementary setting is the My Class Inventory (MCI), and the questionnaire that assesses the interpersonal relationships between student and teacher is the Questionnaire on Teacher Interaction (QTI, Wubbels, 1993; Wubbels & Brekelmans, 1998, 2005). The What Is Happening In this Class? (WIHIC) is the most commonly-used learning environment questionnaire today (Dorman, 2008).

Detailed consideration was paid to the development and application of the College and University Classroom Environment Inventory (CUCEI) questionnaire which was chosen for collecting learning environment data in my research (Section 2.2.3). The original version of the CUCEI assesses the scales of Personalisation, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation and Individualisation. For my research, however, only the scales of Involvement, Task Orientation, Personalisation, Individualisation and Satisfaction were retained in the survey instrument after the validation analyses reported in Section 4.3.

In addition to the review of literature related to the history of learning environment research and various instruments, Chapter 2 also included a review of past research related to learning environments. Special attention was paid to past research involving the CUCEI questionnaire. Although no previous research involved a modified Arabic version of the CUCEI, numerous earlier studies included reporting of the reliability and validity of the instrument. The CUCEI has been used with university and tertiary institute students in the Pacific Islands (Coll, Taylor, & Fisher, 2002), the Netherlands (Olani, Hoekstra, Harskamp, & Van der Werf, 2011), Thailand (Charik & Fisher, 2008), Malaysia (Thangiah, 2005), Spain (Marcelo, 1988) and Australia (Booth, 1997; Fraser, Treagust, & Dennis, 1986). Similar studies have been conducted with high school students in Wellington, New Zealand (Logan, Crump, & Rennie, 2006) and Spain (Phan, 2008), and with preservice teachers in

Australia (Yarrow, Millwater & Fraser, 1997), Singapore (Khine & Goh, 2001) and the United States (Goyak, 2009).

Chapter 3 was devoted to describing the research methodology followed to investigate the three research questions in my study. Section 3.4 involved the sample used and the population from which it was drawn and Section 3.5 focused on the data-collection methods which involved quantitative and qualitative approaches. The data were collected from 84 adult male students in Abu Dhabi Men's College (Higher Colleges of Technology, HCT). This section also provided more details and background about the instrument used in the research. The CUCEI was administered as a first phase of the data collection at the beginning of the college year and again a few weeks later. Five case study students were involved in collecting the qualitative data (observation and focus groups) to complement the quantitative data.

To answer Research Question 1, concerning the validity of scales, data from the CUCEI were first analysed to check factor structure and reliability. Factor analysis was performed using principal axis factor analysis with varimax rotation and Kaiser normalisation separately for pretest and posttest data. Scale internal consistency reliability was determined by using Cronbach's alpha coefficient for each learning environment scale and Satisfaction for two units of analysis, namely, the individual student and class mean.

The statistical significance of pretest–posttest changes for CUCEI scales was computed using Multivariate Analysis of Variance (MANOVA) with repeated measure to answer Research Question 2. Because the multivariate test revealed significant results overall for the set of five dependent variables using Wilks' lambda criterion, the univariate ANOVA was interpreted separately for each of the five scales. Effect sizes were used to describe the magnitude, or the educational importance, of those differences and were calculated by dividing the differences between means by the pooled standard deviation. An effect size expresses a difference between two means in standard deviation units.

Research Question 3 concerned the use of qualitative research methods to explain how a variety of personally-relevant activities led to changes in the perceptions of adult male students about their mathematics learning environments. Two vignettes were described to illustrate students' experiences, how they reacted to the activity-based teaching strategies, and how they interacted with others during the lesson. Each vignette was followed by a commentary to describe the themes that resulted from the interviews, observations and focus-group interviews, and these themes were linked with the constructs assessed by the CUCEI.

Chapter 4 described the data analyses and results for the three research questions. The major findings of the research are summarised in the following section.

5.3 Major Findings of the Study

The major findings of this study are organised according to each of the research objectives. Each subsection that follows provides a summary of the results of the analyses performed to answer one of the research questions.

To answer the first research question about the validity of the CUCEI questionnaire, Section 5.3.1 is devoted to the findings related to factor analysis and internal consistency reliability for the learning environment scales. Section 5.3.2 provides findings for the second research question, concerning whether the activity-based teaching strategies were effective for adult males in terms of the nature of the classroom learning environment and student satisfaction. The final section, Section 5.3.3, provides a summary of the findings for the use of qualitative research methods for providing more in-depth information about how the use of range of personally-relevant activities changed the learning environment in ways that were perceived to be beneficial to adult males who had experienced failure at school.

5.3.1   Validity and Reliability of the CUCEI Questionnaire

After removing Satisfaction items, items in all other CUCEI scales were subjected to principal axis factoring with varimax rotation and Kaiser normalisation for a sample of 84 students separately for the pretest and posttest data. Varimax rotation produced the maximum distinctions between factors. After the removal of some items, the optimum factor structure emerged for a 16-item version with four learning environments scales. All 16 items had a factor loading of at least 0.40 on their own scale and less than 0.40 on each of the other three scales. The total percentage of variance accounted for by different scales ranged from 7.92% to 38.11%, with the total being nearly 60%. The eigenvalues for different scales ranged from 1.27 to 5.30.

The Cronbach alpha coefficient for each learning environment scale and Satisfaction for two units of analysis, namely, the individual students and the class mean, was calculated. Reliabilities were also calculated separately for the pretest and posttest data. With the student as the unit of analysis, alpha coefficients for the five scales ranged from 0.61 to 0.75 for the pretest and from 0.64 to 0.79 for the posttest. With the class mean as the unit of analysis, alpha coefficients ranged from 0.61 to 0.77 for the pretest and from 0.63 to 0.82 for the posttest. Therefore the CUCEI demonstrated satisfactory factorial validity and internal consistency reliability when used with adult males in the UAE.

5.3.2   Evaluating the Effectiveness of Using Activity-based Teaching Strategies in Mathematics in Terms of Nature of the Classroom Learning Environment and Student Satisfaction

After the instrument had been shown to be valid and reliable for use among adult male students in the UAE, it could be used to investigate the effectiveness of the teaching strategies. The statistical significance of pretest–posttest changes was investigated for each of the scales measuring learning environment and satisfaction using MANOVA with repeated measure. Because the multivariate test yielded significant results overall for the set of five dependant variables using Wilks' lambda criterion, the univariate ANOVA was interpreted for each of the CUCEI's five

scales. The results showed that the pretest–posttest differences were statistically significant for every CUCEI scale.

While the MANOVA was used to explore the statistical significance of changes between pretest and posttest, effect sizes were calculated to provide information about the magnitude or educational importance of these changes. The effect sizes were 2.40 standard deviations (Involvement), 2.38 standard deviations (Task Orientation), 2.44 standard deviations (Personalisation), 1.40 standard deviations (Individualisation) and 2.88 standard deviations (Satisfaction). According to Cohen (1977), all of the effect sizes are large.

The directions of the statistically significant differences between the pretest and posttest were all positive in that adult male students experienced greater Involvement, Task Orientation, Personalisation and Individualisation during the activity-based teaching strategies and had more positive Satisfaction towards the value of mathematics. Overall, these results provide strong support for the effectiveness of the activity-based teaching strategies.

5.3.3 *Use of Qualitative Research Methods to Examine How Using Personally-Relevant and Concrete Activities Changed the Learning Environment in Beneficial Ways.*

The results for the CUCEI were supplemented by qualitative information collected from case-study students through class observations, interviews with participants and narrative stories which allowed me to triangulate the results from the two methods. The interpretation of the quantitative data became more meaningful when combined with data gathered using other research methods (e.g. the narrative indicated that students previously had experienced teacher-centred lessons at school during which they appeared to play a very passive role). However, when students experienced activity-based teaching strategies, they had opportunities to discuss their ideas and they became more engaged in the learning process (pre–post changes on Involvement = 2.40 standard deviations). All students interviewed had similar opinions about being on task because the activity-based teaching strategies allowed them to learn mathematics through collecting information, making notes of facts and hypotheses

and discussing the results with their peers or teacher (pre–post changes on Task Orientation = 2.39 standard deviations). The feedback that I received from my students is that I created a supportive learning environment for them through being friendly and approachable, which led to effective learning (pre–post changes on Personalisation = 2.44 standard deviations). One of intentions of applying the activity-based teaching strategies was to overcome the fear and anxiety that students had towards mathematics, and the interviews revealed that students felt relaxed and enthusiastic during the activities and that I was careful in ensuring that each student could work at his own pace and to apply strategies that work for each individual (pre–post changes on Individualisation = 1.40 standard deviations). In general, students were satisfied with the activity-based teaching strategies as they felt that they were enjoyable, engaging, motivating, interesting and encouraging and were satisfied with the mathematics learning process (pre–post changes on Satisfaction = 2.88 standard deviations).

The qualitative data provided valuable insights about how the use of activity-based teaching strategies changed adult male students' perceptions towards learning mathematics after experiencing failure in the past. The magnitudes and statistical significance of pre–post changes in the quantitative questionnaire data were consistent with the qualitative data, thus supporting the effectiveness of the activity-based teaching strategies.

5.4   Limitations and Suggestions for Future Research

Limitations and biases can appear in any research (Anderson, 1995). In order to minimise these limitations and biases, accurate planning was undertaken and authentic information was recorded during this study.

My sample size and scope gave rise to limitations in my study. The sample only comprised a small group of adult male students in one college in Abu Dhabi. It is recommended, therefore, that further similar research be carried out to investigate the benefits of using activity-based teaching strategies in other colleges in Abu Dhabi and in the other six Emirates in terms of the learning environment and a variety of

student outcomes. Therefore, additional studies with larger samples from the entire seven Emirates are desirable. Furthermore, because the sample size used in this study of 84 adult male students was modest (but still adequate to allow the statistical analyses needed), the use of larger samples in future research would provide more dependable results.

The sample was drawn from Emirati students only. To increase the validity of the research, a greater diversity of cultural backgrounds should be involved in future research, such as Iraqi, Jordanian, Sudanese and other nationalities. This would lead to greater generalisability of findings.

Another potential limitation in the qualitative part of my study is that participants could have been under pressure to overemphasise the positive side of their story, therefore, leading to bias in their answers (Yin, 1994). I attempted to reduce this pressure by providing the students with information about the nature of the research including: the data collection methods; the purpose of the research; the risks and benefits to the participants; and the possible outcomes of the research. Students were informed that not taking part in the research would not affect their marks at the end of the year, and that their participation was voluntary and that they were free to withdraw from the research at any time without prejudice or negative consequences. Furthermore, conducting the interviews privately in the college minimised these pressures, because students were not on public display. I also made it clear to the participant students that I intended to publish findings based upon data collected from different types of students who had experienced difficulties in learning mathematics.

With respect to the limitations of the quantitative part of the research, I had to eliminate incomplete or recklessly-answered questionnaires, thus reducing the effective number of participants. Disregarding partially-answered questionnaires potentially could give rise to limitations (Little & Rubin, 1987). However, because the eliminated questionnaires formed a representative and relatively minor proportion of my complete dataset, deletion was the best approach.

In my study, most participant students were weak in Arabic and English was their second language. Therefore, many students did not seem to understand the negatively-worded questions in the CUCEI. For example, Items 3, 24 and 31 in Student Cohesiveness scale and Items 6, 13, 34 and 48 in the Innovation scale are negatively-worded and reversed-scored (see Appendix A). Eliminating all items in these two scales enhanced the reliability and factor structure of the instrument.

Given the opportunity to spend more time in classrooms, I would recommend conducting additional research using scales from other instruments with similar populations. While I limited my research to the scales of the CUCEI only, I believe that it would be interesting to investigate further the effectiveness of activity-based teaching strategies by using scales from other learning environment instruments reviewed in Chapter 2 such as the CLES or WIHIC.

The criteria of effectiveness used in my study – namely, the learning environment and student satisfaction – were both appropriate and informative. Nevertheless, in future research, it would be desirable to include additional criteria of effectiveness, especially student achievement in mathematics.

Because the sample for my research consisted only of male students, my findings concerning the effectiveness of the teaching strategies used cannot be applied to female students. Therefore, in the future, it would be desirable to conduct a similar study with a sample of female students.

5.5   Significance and Implications of this Study

This research is significant because it is one of the first studies of learning environment conducted in the United Arab Emirates. It is also significant in that a carefully modified and translated version of the CUCEI has been validated and made available to educators and researchers in the United Arab Emirates. The research also represents one of the few learning environment studies anywhere in the world that focused on the effectiveness of activity-based teaching strategies in mathematics in terms of the classroom environment perceived by adult male students.

Educators' enthusiasm to integrate activity-based teaching strategies into their lessons was a key to success in enhancing the classroom learning environment and students' satisfaction towards mathematics. However, some teachers find these strategies time consuming and prefer traditional activities, such as paper-and-pencil worksheets, because they perceive the inflexibility of the curriculum and time pressures as major impediments (McDonald & Hannafin, 2003). Hopefully, the outcomes of the present research are likely to motivate educators of mathematics to use more creative pedagogical practices that can help to improve the classroom learning environment and students' satisfaction.

Activity-based teaching strategies which involve games, puzzles and hands-on activities provide students with experience in experimentation, exploration, simulation, imagination and trial-and-error (Khine & Saleh, 2009). Also, researchers draw attention to the potential of activities to support participation, competencies and collaboration (Kirriemuir & McFarlane, 2004). Khine and Saleh (2009) suggest that the challenges that lie ahead for educators are to draw on teaching strategies to alter traditional approaches to a new learning model that involves the use of activities that include educational games and simulations in the formal curriculum. They also recommend that teachers can capitalise on the motivational power of activities in the classrooms to promote a more enjoyable learning environment.

Educators are likely to be interested in my finding that the CUCEI was valid and reliable when used with college adult male students who had experienced difficulties with learning mathematics in the past in the United Arab Emirates. The findings of this study could guide educators in the future in improving learning environments and students' satisfaction in mathematics in colleges in the UAE and elsewhere.

My study adds to the richness of learning environment research with a primary focus on the mathematics learning environment classroom (e.g. Chionh & Fraser, 2009; Dorman, 2001; Kilgour, 2006; Majeed, Fraser & Aldridge, 2002; Mink & Fraser, 2005; Moldavan, 2007; Ogbuehi & Fraser, 2007; Spinner & Fraser, 2005). Relatively few past learning environment studies have focused specifically on mathematics

classes, and none of these focused on college adult male students who had experienced difficulties learning mathematics when they attended school.

5.6   Summary

The learning environment is usually associated with the psychological, emotional conditions of the classroom, as well as social and cultural impacts. The concept of human environment has existed since Lewin's (1936) seminal work in non-educational settings recognised that both the environment and its interaction with characteristics of the individual are potent determinants of human behaviour. In 2007, Fraser claimed that the results of past studies conducted over the past 35 years have consistently confirmed that the quality of the classroom environment is an important determinant of student learning. This implies that students learn better when they perceive the classroom environment more positively (Dorman & Fraser, 2009).

It is my hope that, through the research reported here, I will be able to contribute to educational developments in the UAE in terms of improving adult male students' classroom learning environments and satisfaction with mathematics, especially those students who previously had experienced failure, but also to stimulate further research in the field of learning environments in the UAE and other Arabic-speaking countries.

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APPENDIX A

College and University Classroom Environment Inventory (CUCEI)

Actual Form

Directions

The purpose of this questionnaire is to find out your opinions about the class you are attending right *now/attended at school.*

This form of the questionnaire assesses your opinion about what this class is *actually like.* Indicate your opinion about each questionnaire statement by circling:

SA   if you STRONGLY AGREE   that it describes what this class is actually like

A   if you AGREE   that it describes what this class is actually like

N   if you are NEUTRAL   that it describes what this class is actually like

D   if you DISAGREE   that it describes what this class is actually like

SD   if you STRONGLEY DISAGREE   that it describes what this class is actually like

Personalisation items: 1, 8, 15, 22, 29, 36 and 43.

Involvement items: 2, 9, 16, 23, 30, 37 and 44.

Students Cohesiveness items: 3, 10, 17, 24, 31, 38 and 45.

Satisfaction items: 4, 11, 18, 25, 32, 29 and 46.

Task Orientation items: 5, 12, 19, 26, 33, 40 and 47.

Innovation items: 6, 13, 20, 27, 34, 41 and 48.

Individualisation is items: 7, 14, 21, 28, 35, 42 and 49.

Name: ---

Section: ---

Date: ---

	STRONGLY DISAGREE غير موافق بتاتا	DISAGREE غير موافق	NEUTRAL محايد	AGREE موافق	STRONGLY AGREE موافق بشدة
1. The instructor considers students' feelings. الأستاذ يراعي مشاعر الطلاب	☐	☐	☐	☐	☐
2. The instructor talks rather than listens. الأستاذ يتكلم بدل الاستماع	☐	☐	☐	☐	☐
3. The class is made up of individuals who don't know each other well. الصف مكون من افراد لا يعرفون بعضا جيدا	☐	☐	☐	☐	☐
4. The students look forward to coming to classes. الطلاب يتوقون الى المجئ للصفوف	☐	☐	☐	☐	☐
5. Students know exactly what has to be done in our class. الطلاب يعرفون تماما ما يجري في الصف	☐	☐	☐	☐	☐
6. New ideas are seldom tried out in this class. الأفكار الجديدة نادرا ماتجرب في هذا الصف	☐	☐	☐	☐	☐
7. All students in the class are expected to do the same work, in the same way and in the same time. المتوقع من الطلاب أن يعملوا بالطريقة نفسها وبالوقت نفسه	☐	☐	☐	☐	☐

8. The instructor talks individually with students. الأستاذ يتكلم بأنفراد مع الطلاب	☐	☐	☐	☐	☐
9. Students put effort into what they do in classes. الطلاب يبذلون جهدا في الصف	☐	☐	☐	☐	☐
10. Each student knows the other members of the class by their first names. يقتصر معرفة الطلاب لبعضهم البعض على الأسم الاول فقط	☐	☐	☐	☐	☐
11. Students are dissatisfied with what is done in the class. الطلاب غير راضين بما يجري في الصف	☐	☐	☐	☐	☐
12. Getting a certain amount of work done is important in this class. من المهم جدا أن تنفذ كمية معينة من العمل في هذا الصف	☐	☐	☐	☐	☐
13. New and different ways of teaching are seldom used in this class. طرائق تدريس جديدة ومختلفة نادرا ما تستعمل في هذا الصف	☐	☐	☐	☐	☐
14. Students are generally allowed to work at their own pace. الطلاب يعملون كل حسب سرعته بصورة عامة	☐	☐	☐	☐	☐

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15. The instructor goes out of his/her way to help students. الأستاذ يستعمل اساليبه الخاصة لمساعدة الطلاب	☐	☐	☐	☐	☐
16. Students 'clockwatch' in this class. الطلاب يراقبون الوقت في هذا الصف	☐	☐	☐	☐	☐
17. Friendships are made among students in this class. الصداقات تكون بين طلاب في هذا الصف	☐	☐	☐	☐	☐
18. After the class, the students have a sense of satisfaction. الطلاب يشعرون بالرضا بعد انتهاء الصف	☐	☐	☐	☐	☐
19. The group often gets off track instead of sticking to the point. الطلاب غالبا ما يتشتتون بدل التركيز	☐	☐	☐	☐	☐
20. The instructor comes up with innovative activities for students to do. الأستاذ يجهز نشاطات جديدة للطلاب	☐	☐	☐	☐	☐
21. Students have a say in how class time is spent. الطلاب يلعبون دورا في كيفية قضاء الوقت في الصف	☐	☐	☐	☐	☐

22. The instructor helps each student who is having trouble with the work. الأستاذ يساعد كل طالب يعاني من المشاكل	☐	☐	☐	☐	☐
23. Students in this class pay attention to what others are saying. طلاب هذا الصف ينتبهون لما يقوله البعض	☐	☐	☐	☐	☐
<u>24</u>. Students don't have much chance to get to know each other in this class. طلاب هذا الصف ليس لديهم الفرصة للتعرف على بعضهم البعض	☐	☐	☐	☐	☐
<u>25</u>. Classes are a waste of time. الدروس هي مضيعة للوقت	☐	☐	☐	☐	☐
<u>26</u>. This is a disorganised class. هذا الصف غير منتظم	☐	☐	☐	☐	☐
27. Teaching approaches in this class are characterised by innovation and variety. طرائق التدريس في هذا الصف تتصف بالأبداع والتنوع	☐	☐	☐	☐	☐
28. Students are allowed to choose activities and how they will work. يسمح للطلاب اختيار نشاطاتهم وكيفية تنفيذها	☐	☐	☐	☐	☐

29. The instructor seldom moves around the classroom to talk with students. الأستاذ نادرا ما يتحرك في الصف ليكلم الطلاب	☐	☐	☐	☐	☐
30. Students seldom present their work to the class. الطلاب نادرا ما يعرضون عملهم للصف	☐	☐	☐	☐	☐
31. It takes a long time to get to know everybody by his/her first name in this class. معرفة البعض بأسمائهم الأولى يحتاج وقتا طويلا	☐	☐	☐	☐	☐
32. Classes are boring. الدروس مملة	☐	☐	☐	☐	☐
33. Class assignments are clear so everyone knows what to do. المهام الصفية واضحة بحيث الكل يعرف ماذا يفعل	☐	☐	☐	☐	☐
34. The seating in this class is arranged in the same way each week الجلوس في هذا الصف منظم بالطريقة نفسها كل اسبوع	☐	☐	☐	☐	☐
35. Teaching approaches allow students to proceed at their own pace. طرائق التدريس تسمح للطلاب أن يعملوا بسرع متفاوتة, كل حسب سرعته	☐	☐	☐	☐	☐

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<u>36.</u> The instructor isn't interested in students' problems. الأستاذ غير مهتم بمشاكل الطلاب	☐	☐	☐	☐	☐
37. There are opportunities for students to express opinions in this class. هناك فرص للطلاب للتعبير عن ارائهم في هذا الصف	☐	☐	☐	☐	☐
38. Students in this class get to know each other well. يسمح لطلاب هذا الصف أن يعرفوا بعضا	☐	☐	☐	☐	☐
39. Students enjoy going to this class. الطلاب يستمتعون بالذهاب لهذا الصف	☐	☐	☐	☐	☐
<u>40.</u> This class seldom starts on time. هذا الصف نادرا ما يبدا بالوقت المحدد	☐	☐	☐	☐	☐
41. The instructor often thinks of unusual class activities. الأستاذ غالبا ما يفكر بنشاطات غير اعتيادية	☐	☐	☐	☐	☐
<u>42.</u> There is little opportunity for a student to pursue his/her particular interest in this class. هناك فرصة ضئيلة لكي يحقق الطالب ما يريد في هذا الصف	☐	☐	☐	☐	☐

43. The instructor is unfriendly and inconsiderate towards students. ألأستاذ مهمل ولايعد صديقا للطلاب	☐	☐	☐	☐	☐
44. The instructor dominates class discussions. الأستاذ يستقطب النقاشات الصفية	☐	☐	☐	☐	☐
45. Students in this class aren't very interested in getting to know other students الطلاب في هذا الصف غير مهتمون بمعرفة بعضهم البعض	☐	☐	☐	☐	☐
46. Classes are interesting. الصفوف ممتعة	☐	☐	☐	☐	☐
47. Activities in this class are clearly and carefully planned. النشاطات في هذا الصف مخططة بحذر ووبوضوح	☐	☐	☐	☐	☐
48. Students seem to do the same type of activities every class. يبدو أن الطلاب يفعلون نفس النشاطات كل درس	☐	☐	☐	☐	☐
49. It is the instructor who decides what will be done in our class. الأستاذ هو الذي يقرر ماذا سوف يجري في الصف	☐	☐	☐	☐	☐

Items whose number is underlined are negatively-worded and need to be reverse scored

This questionnaire was developed by Fraser, Treagust and Dennis (1986) and is described in Section 2.2.3. It was used in this study and is included in this thesis with the permission of the authors

Curtin University

Science and Mathematics Education Centre

Case Study–Participant Information Sheet

My name is Abeer Abdulla Hasan and I am mathematics lecturer at the Higher Colleges of Technology. I am currently completing a piece of research for my Degree of Doctorate at Curtin University of Technology.

Purpose of Research

The purpose of this research is to examine the effectiveness of teaching strategies that engage college students who experienced childhood difficulties learning mathematics in the United Arab Emirates (UAE).

The purpose of this Information Sheet is to invite you to be a case study within the research. Case studies will allow me to collect detailed data on how these teaching strategies have affected the nature of your class learning environment and your satisfaction towards learning mathematics concepts.As a case study participant you will be interviewed at the end of each week, at a convenient time and place. The interview should last no longer than 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 or my 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 only have access to this. The interview transcript will not have your name or any other identifying information on it and in adherence to university policy, the 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

If you would like further information about the study, please feel free to contact me on: 00 971 507625791, or by email: abeerhasan@hotmail.com. Alternatively, you can contact my supervisor Professor Barry Fraser on +618 9266 7896 or by e-mail: b.fraser@curtin.edu.au

Thank you very much for your involvement in this research.
Your participation is greatly appreciated.

CONSENT FORM – CASE STUDY

• I understand the purpose and procedures of the study.

• I have been provided with the participation information sheet.

• I have been provided with the participation information sheet.

• I understand that my involvement is voluntary and I can withdraw at any time without problem.

• I understand that my participation will not affect any of my exam results during the mathematics course.

• 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 five 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: _____

Curtin University

Science and Mathematics Education Centre

Focus Group –Participant Information Sheet

My name is Abeer Abdulla Hasan; I am currently completing a piece of research for my Degree of Doctorate at Curtin University of Technology.

Purpose of Research
The purpose of this research was to investigate the effectiveness of using activity-based teaching strategies with adult males in terms of the nature of the classroom learning environment and students' satisfaction.

The purpose of this Information Sheet is to invite you to be a focus-group participant within the research. As part of a focus-group you will be interviewed with a small group of your peers, at a convenient time and place, about your perceptions of the different teaching strategies used to teach mathematics. The focus-group interview should take no longer than 30 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 or my 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 only have access to this. The interview transcript will not have your name or any other identifying information on it and in adherence to university policy, the 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 of Technology Human Research Ethics Committee. If you would like further information about the study, please feel free to contact me on: 00 971 507625791, or by email: abeerhasan@hotmail.com. Alternatively, you can contact my supervisor: Professor Barry Fraser on+ 618 9266 7896 or by e-mail: b.fraser@curtin.edu.au

Thank you very much for your involvement in this research.
Your participation is greatly appreciated.

CONSENT FORM – FOCUS GROUP

• I understand the purpose and procedures of the study.

• I have been provided with the participation information sheet.

• I have been provided with the participation information sheet.

• I understand that my involvement is voluntary and I can withdraw at any time without problem.

• I understand that my participation will not affect any of my exam results during the mathematics course.

• 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 C

<u>Case Study Questions</u>

First week interview questions

أسئلة مقابلة الأسبوع الأول

1. Tell me about you? Age/job.

أخبرني عن عمرك\ وظيفتك؟

2. Tell me about your mathematics background. Primary school, high school?
   How far have you progressed through school?

أخبرني عن خلفيتك العلمية بالرياضيات. أبتدائي أم ثانوي؟ وكم تقدمت خلال المدرسة؟

3. Did you like mathematics at school? What is it that you do or do not like about
   mathematics?

هل كنت تحب الرياضيات في المدرسة؟ ما هو الشئ الذي تحبه\ لا تحبه بالرياضيات؟

4. Do you think mathematics is an important subject to know? Why or why not?

هل تعتقد أن الرياضيات هو درس مهم للتعلم؟ لماذا؟

Weekly interview questions for the case study

Semi-structured Interviews

. ألمقابلة الأسبوعية

1. This week in class we used the strategy about producing a mini project of a certain topic in mathematics and we consolidated the topic by playing a relative game. What did you think of this strategy?

هذا الأسبوع استخدمنا ستراتيجية في انتاج مشروع مصغر عن موضوع معين بالرياضيات وعززناه بلعب لعبة مناسبة، ما هو رأيك بهذه الطريقة؟

2. Did this strategy help you to become more engaged in class? Tell me how by giving me examples of what happened in class this week?

هل جعلتك هذه الأستراتيجية متفاعلا" أكثر خلال الدرس؟ أخبرني كيف بأعطائي أمثلة عما حدث بالصف هذا الأسبوع.

3. Did this strategy help you to understand mathematics? Tell me how by giving me examples of what happened in class this week?

هل ساعدتك هذه الأستراتيجية على فهم الرياضيات أكثر؟ أخبرني كيف بأعطائي أمثلة عما حدث بالصف هذا الأسبوع.

4. Is there anything else you would like to say about this strategy?

هل هناك شي اخر تود أن تضيفه عن هذه الأستراتيجية؟

1. Have you used games, puzzles and or any other activity to help you learn mathematics in the past?

هل استعملت العابا او مشاريع مصغرة مسبقا لمساعدتك بالرياضيات؟

2. Did you feel more engaged when using a variety of activities? Why or why not? Can you give me an example from class?

هل شعرت بالأندماج عند استعمال هذه الألعاب؟ لم ؟ أو لم لا؟ هل ممكن تعطيني مثالا حيا؟

3. Did you feel more motivated to learn when using the games and mini-projects? Why or why not? Can you give me an example from class?

هل شعرت بالأندفاع للتعلم عند لعبك هذه الألعاب أو المشاريع المصغرة ؟ لم ؟ او لم لا؟ هل ممكن تعطيني مثالا حيا؟

4. Do you think you understand mathematics better through using these activities? Why or why not? Can you give me an example from class?

هل تعتقد أنك تفهم الرياضيات أكثر من خلال ممارستك لهذه الألعاب أو المشاريع المصغرة؟ ؟ لم ؟ او لم لا؟ هل ممكن تعطيني مثالا حيا؟

5. Do you think these strategies developed a more inclusive mathematics learning environment in your classroom? Why or why not? Can you give me an example from class?

هل تعتقد أنه هذه الأساليب قد طورت الجو الدراسي في صف الرياضيات؟ ؟ لم ؟ او لم لا؟ هل ممكن تعطيني مثالا حيا؟