Science and Mathematics Education Centre

Determinants and Effects of the Learning Environment

in College Classes

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any other university.

ABSTRACT

This study investigated sex, age, and ethnicity as determinants of classroom environment, as well as the effects of classroom environment on student attitudes at an urban two-year or junior college in Florida, USA. The sample consisted of 544 students in 29 classes that were randomly chosen.

The Constructivist Learning Environment Survey (CLES) was used to assess the way in which students perceived their classroom environment, whereas a modified version of the Enjoyment of Science Lessons scale from the Test of Science-Related Attitudes (TOSRA) was used to assess students' attitudes toward the subject taught in the classes surveyed. Data analyses supported the CLES's factorial validity, internal consistency reliability, and its ability to differentiate between classrooms when used with adult learners in a post-secondary setting. Similarly, results from analyses conducted on the revised TOSRA scale revealed satisfactory internal consistency reliability.

A three-way MANOVA for sex, age and ethnic differences in classroom environment perceptions and enjoyment revealed that: females enjoyed their classes significantly more than did males; students 25 years and older had higher Shared Control and Enjoyment scores, but lower Student Negotiation scores, than did students younger than 25 years; and there were no significant differences between African-Americans and students of other ethnicities for any learning environment scale or for enjoyment. A large effect size of 0.88 standard deviations, suggesting an educationally important sex difference, was found for the attitude scale. However,

effect sizes of modest magnitude, ranging from 0.21 to 0.29 standard deviations, were found for age difference.

Past research was replicated in that positive and statistically significant bivariate and multivariate associations were found between students' enjoyment of classes and their perceptions of classroom learning environment. In particular, students enjoyed their classes more when there was a greater emphasis on Shared Control and Student Negotiation. In order words, students responded more positively when they perceived that they had a role to play in the design and management of the learning environment, as well as when opportunities existed for them to explore among their peers the viability of newly developing ideas.

Overall, my results suggest that the CLES and the TOSRA are valid and reliable instruments that researchers can use with confidence to measure adult students' perceptions of learning environment and attitudes, respectively, in the two-year college setting. While no significant sex difference was found for any learning environment scale, females enjoyed their classrooms more than did males. Relative to younger students, older students had higher Student Negotiation and Enjoyment scores. A possible implication is that teachers should make classrooms more appealing and enjoyable to males, while making younger adults feel a greater sense of inclusion in their classrooms.

DEDICATION

I dedicate this thesis to my mother, who continues to offer words of advice and encouragement, and to the memory of my grandmother and my great aunt. These three women made everything in my life possible because of their love, care and direction. I am eternally grateful for the nurturing environment in which they raised me and I will always be indebted to them.

Deo gratia. Opus magnum meum factum est. Labor omnia vincit!

ACKNOWLEDGEMENTS

These words from author Karen Ravn cogently capture the underlying motivational factors that have taken me to this milestone in my life: "Only as high as I reach can I grow, only as far as I seek can I go, only as deep as I look can I see, only as much as I dream can I be."

Long before I was even able to understand what a doctoral degree was, I declared to friends and family that seeking just such an achievement would be one of the aspirations of my life. However, the journey from that simple declaration to its realization has not been an easy one.

Long and circuitous, my quest has lasted several decades, it has taken me across several national borders and it has made me a former student of many institutions. I have made many sacrifices and have dedicated incalculable resources to make this dream a reality. Still, I could not have done it alone.

My supervisor, Dr Barry Fraser, deserves more credit than mere words can express. His advice, his patience, his understanding, his encouragement, his dedication and his guidance made me "look ever forward" when the road ahead seemed impassable and when I did not know how to navigate the many obstacles that I encountered. Without Dr Fraser's help, I simply could not have completed this thesis.

I would also like to thank Dr Arulsingam L. Chandrasegaran from Curtin University for assisting me with the analysis and interpretation of the data. He turned fuzzy-

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BACKGROUND TO THE STUDY

1.1   Introduction

What goes on in school and college classrooms is without question of enormous importance to a variety of interests, but perhaps none more so than students and teachers – the two groups that are on the frontlines of every educational practice. In advancing this argument, Fraser (2001) points out, however, that educational researchers have disproportionately relied on the assessment of achievement and other learning outcomes to make decisions about enhancing quality. Careful not to diminish the worth of achievement in informing such decisions, he argues that its value, notwithstanding, provides only a partial view of the educational landscape.

Fraser (2001) asserts that having positive classroom environments is a valuable goal of education, much like the goal of having favourable learning outcomes. He then adds that so compelling is the evidence that the classroom environment strongly influences student outcomes that it should not be ignored by those wishing to improve educational effectiveness. Students, he posits, are uniquely qualified to make judgments about their classrooms because of the many different learning environments that they have experienced and the amount of time that they have spent in these classrooms. He thinks that such experiences have been enough for them to form accurate opinions and that questionnaires that have been developed in

the last 40 years and used around the world can provide valuable insight about the way in which students perceive their classroom environment and how they respond affectively.

It is against this backdrop that the main questions that guided this study arose. What role do demographic factors play in influencing how students perceive their classroom environment and do these factors affect whether or not students enjoy their educational settings? Specifically, do students of different sexes, ages and ethnic backgrounds experience the classroom differently? In the American context, sex, age and ethnicity are of major significance in all educational settings. Every school and college is involved in collecting such demographic data and almost all educational outcomes are broken down and interpreted along these lines. In the same vein, this study sought to determine whether associations exist between attitudes and enjoyment and the sex, age and ethnicity of students in an American two-year college setting.

The purpose of the present chapter is to provide background information about the study, to outline its context, theoretical framework, rationale, significance and research questions and to overview the other chapters. It is organized into a number of sections for ease of reading and reference. Section 1.1 is the introduction. The context of the study is described in Section 1.2. The theoretical framework, which involves the learning environment and factors that shape it, is laid out in Section 1.3. The questionnaires that were used in the study – the Constructivist Learning Environment (CLES) and Test of Science-Related Attitudes – are briefly described in Section 1.4. The specific research questions that guided the study are outlined in

Section 1.5. The significance of the study is addressed in Section 1.6, and an overview of the thesis is given in Section 1.7.

1.2   Context of the Study: Miami Dade College

Miami Dade College, the setting in which this study took place, is a large, urban multi-campus two-year college located in Florida. It is a publicly-supported institution, which first opened its doors for instruction in 1960. In the United States, the two-year college, which is also known as a junior college, is an educational institution offering a two-year course that is generally the equivalent of the first two years of a four-year undergraduate course (Junior College, n.d.).

This Florida institution has an open-door admissions policy, which means that it accepts students without regard to their entering level of basic skills. The Miami Dade College 2006–2008 catalogue states that:

> [The] policy provides educational opportunities to community residents and to national and international applicants. Anyone seeking to benefit from the degree or short-term certificate programs, or from the college's student and community services, is encouraged to enrol. The college welcomes all students regardless of sex, race, colour, religion, marital status, age, national origin or disability. (*Miami Dade College Catalog 2006–2008*, p. 6)

This philosophy of student-centredness seems implicit in and congruent with Miami Dade College's mission statement: "The mission of Miami Dade College is to provide accessible, affordable high quality education by keeping the learner's needs at the centre of decision-making and working in partnership with its dynamic, multicultural community" (Miami Dade College). The statement suggests that the

college is interested in an active and adaptive learning environment with students at the centre as they pursue knowledge.

Table 1.1 profiles the student body of 160,000 students in the fall semester of 2008. The table shows the composition of the population according to the students' sex, age and ethnic identities. Three-fifths are females, the average age is just over 26½ years, and Hispanics make up two-thirds of the student body and far outnumber every other ethnic group.

Table 1.1   Sex, Age and Ethnic Profile of Miami Dade College Students in Fall 2008

Demographic Variable	Percentage
Sex	
• Female	60
• Male	40
Age	
• 20 or younger	36
• 21 – 25	31
• 26 or older	33
Mean Age = 26.65	
Ethnicity	
• Hispanic	68
• Black Non-Hispanic	19
• White Non-Hispanic	9
• Other	4

Source: Fall Profile 2008, Enrolled Student Survey Fall 2008, College Fact Book

The term often used to describe the student body profiled above is 'diverse'. However, such diversity comes with strings attached. Because of its 'open-door' policy, the institution recruits and admits most new students – about three out of every four – who need to complete preparatory work in reading, writing, or

mathematics or a number of courses of English as a second language before they are ready to transition to college-level work. Teaching remedial or developmental courses is a challenging task for two reasons. One is obvious – the lack of preparedness or the deficiency skill levels of the students. The other is not so apparent – the attitude toward remediation.

Of the thousands of students who require remedial courses each semester, only the most informed or mature students accept and appreciate the fact that placement into remedial courses is based on data collected from one of the entrance tests that all new entrants must take. They seem to understand that the coursework is designed to help them to improve their skills to college level. Many, however, view remedial courses with some degree of dissatisfaction, see placement as punitive, and openly express the view that the college simply retains them in remedial courses to maximize the revenue it collects from tuition.

Finding ways to change perceptions in order to optimize student satisfaction and boost achievement in an environment that is stigmatized is no small task. To compound the problem of skills deficiency, the students – male and female adult learners – differ widely in age and ethnic origin. Faced with this problem of perception by people from very varied backgrounds, this researcher felt compelled to seek answers to recurring questions about what such different students bring to the learning environment and how such differences influence how they perceive and interact in the situation in which they find themselves.

1.3   Theoretical Framework

Kayler and Swanson (2008) observe that "[w]ith increasing diversity and wide range of learning preferences within classrooms … it is important to provide multiple opportunities for learners to construct their own knowledge, draw upon their expertise and feel supported in their own development" (p. 20). In order to foster this student-centred approach to teaching and meet their diverse needs, it seems logical that a teacher would want to know how his or her students perceive their learning environment – the task that was central to this study, which I undertook in the belief that knowledge of the learning environment can assist teachers in planning and implementing constructivist pedagogical practices that value students' background knowledge, their personal experiences, and the individual contributions they make in a classroom environment (Ciminelli, 2009).

Section 1.3.1 below considers ideas from the field of learning environments, including questionnaires for assessing learning environment. Sex, age, and ethnic differences are introduced in Section 1.3.2 and discussed in respective subsections: Subsection 1.3.2.1 focuses on sex; Subsection 1.3.2.2 is about age; and Subsection 1.3.2.3 is dedicated to ethnicity.

1.3.1   Learning Environment and Development of Instruments to Assess It

Having taught diverse groups of students over many years, I had often wondered whether their demographic differences in any way influenced any of their educational outcomes. Do males perform better in some subjects than do females? What difference does age play in a college classroom in which adult students of

various age ranges are present? Does ethnicity affect educational outcome? These and other questions about the learning environment often occupied my mind. I was often troubled by some of the answers that different people sometimes gave to those questions and soon I became strongly motivated to undertake the present study.

My interest in the link between student demographic and learning outcomes eventually led me to discover that numerous research efforts in recent years have consistently established that students' perceptions of their classroom psychosocial environment significantly influence their cognitive and affective learning outcomes (Fraser & Fisher, 1982; McRobbie & Fraser, 1993; Yarrow, Millwater & Fraser, 1997). Taylor, Fraser and Fisher (1997) report the existence of consistent relationships between the way in which students perceive their learning environment and the way in which they respond cognitively and affectively. The learning process, clearly, was subject to a variety of environmental influences. I wanted to learn more, especially about the students that I usually teach.

Von Glaserfeld (1989) states that "knowledge is not received passively but is built up by the cognising subject [and] that the function of cognition is adaptive and enables the learner to construct viable explanations of experiences" (p. 162). Fraser (1986a) states that "meaningful learning is a cognitive process in which individuals make sense of the world in relation to the knowledge that they have constructed, and this sense-making process involves active negotiation and consensus building" (p. 13).

Taylor, Dawson, and Fraser (1995), Taylor, Fraser and Fisher (1997) and Fraser (1998a) consider that pioneering work on the use of classroom environment assessments began in the late 1960s. Herbert Walberg and Rudolf Moos, each working independently, were the forerunners. Working on Harvard Project Physics, Walberg developed the Learning Environment Inventory (LEI) for use in the research and evaluation activities of the project (Walberg & Anderson, 1968). Meanwhile, Moos pioneered the development of the Classroom Environment Scale (CES), an evolution of his social climate scales, which were geared for use among inmates in psychiatric hospitals and correctional institutions (Moos, 1979; Moos & Trickett, 1974).

Since the first two instruments emerged several decades ago, many other instruments have been developed to assess students' perceptions of a variety of classroom environments (Spinner & Fraser, 2005). Fraser (1998b) makes the point that, over time, researchers developed numerous adaptations of these instruments to measure perceptions. He lists an extensive array of those that are of contemporary importance and provides a detailed overview of their development and format, among other things (see Section 2.4). Fraser (1998a) refers to the development and propagation of these instruments as "remarkable growth, diversification, and internationalization" (p. 1) and, more importantly, reports that the instruments have been found to be useful and valid in many countries.

1.3.2   Sex, Age and Ethnic Differences in the Learning Environment

As ever-present demographic factors in all classrooms, sex, age and ethnicity justifiably or unjustifiably always feature in discussions about educational outcomes. Especially when there are pronounced demographic differences in a classroom setting, arguments are often made to support or to question the results of any educational research. As a researcher, I wanted to know what empirical evidence would reveal about these multiple identities.

Maher and Ward (2002) state that the learning environment is not insulated and that students bring with them all sorts of cultural assumptions, social influences, and contextual dynamics. Some of the more obvious influences are associated with sex, age and ethnicity. These characteristics apparently interact and contribute to the way in which each student perceives and experiences the learning environment. According to Social Class Effects and Multiple Identities (2007), "[t]ogether, these social categories act as structuring mechanisms which shape students' experiences and learning outcomes" (p. 67).

1.3.2.1   Sex

Marklein (2005, para. 6) reports that, in 2004, there were "more men than women ages 18–24 years in the USA – 15 million vs. 14.2 million, according to a Census Bureau estimate", adding later that the national male to female ratio on campus a year later was 43 to 57. Despite the greater number of women on campus, Muhammad and Dixson (2008), drawing on Rankin and Reason (2005) and Swim,

Hyers, Cohen and Ferguson (2001), state that "campus environments generally remain androcentric, reflective of male cultural customs, norms, and mores" (p. 116). Additionally, they write:

> Not only are campus environments male-centred, but they also tend to privilege the Euro-American, middle- to upper-class heterosexual. People on the campus who are neither male, white, middle to upper class are least likely to find cultural affinity or feel culturally safe on campus. (p. 116)

Hodge (2002) shares a not-too-dissimilar view. "Males in general", she writes, "are accorded more opportunities and benefits in the larger society than females … and typically do not experience unequal treatment just because they are male" (p. 114). She further maintains that "although both men and women can be targets and victims of discrimination, being a woman is a better predictor of inequality than variables such as age, race, and social class" (p. 114). If this observation is true, it does not seem to deter women from enrolling in college as the figures cited earlier might suggest, and it does not seem to prevent them from thinking positively about the learning environment.

In fact, Sullivan, Riccio and Reynolds (2008) conducted a study which revealed that females in the age range 8–18 years reported more satisfaction with school, higher levels of affiliation with school, and more positive relationships with teachers compared to males in the same age range, who reported more negative attitudes. According to Lewin (2006), men trail women in more than just enrolment. In general, they get worse grades than women, are less likely to complete their undergraduate degrees, and usually take longer to do so. It is important, therefore, to investigate what might contribute to such sex differences.

1.3.2.2 Age

Today's college students are very different in a number of ways from their counterparts of many years ago. Levin (2007) notes that, in 1970, 25% of postsecondary students were non-traditional whereas, since the 2000s, the figure has risen to 75%. One definition of non-traditional students, according to him, is "those over the age of twenty-four who are engaged in some form of postsecondary learning activities – a definition that is synonymous with 'adult learners'" (p. 23). Because such students are returning to college to advance professionally, age has become an increasingly more important issue (Jaschik, 2010).

The average age of students at Miami Dade College today is approximately 26 years. To accommodate such students, this college, as well as many others around the country, offers courses from very early in the morning to very late at night, every day of the week, on-site and off-site, as well as online. Agbo (2000), citing Millard (1991), observes: "Previously, even in the few institutions having a tradition of academic provision for adult students, the participation of adults was always marginal and limited to non-degree studies through short courses administered by extra-mural and external departments designated as continuing education" (p. 153).

Millard's (1991) observation reflects the situation present a long time ago when younger students attended mainly day classes and older students usually attended a few evening and weekend classes. Today, non-traditional students are the new majority and they bring to the classroom all the experiences that adults have. Surely,

those experiences must have implications for the way in which older students perceive their learning environment.

For the purpose of this study, the age ranges designated on the survey forms were as follows:

- 18–24 years
- 25–34 years
- 35–44 years
- 45–54 years
- 55–64 years.

The groups were chosen merely for convenience of classification and any parallels to Erikson's (1968) stages of psychosocial development that might be drawn were not intended.

1.3.2.3   Ethnicity

According to Johnson-Bailey (2001), "[r]ace and ethnicity are societal issues that interlock with other forces such as gender, age, and sexual orientation all of which serve to order the world" (p. 91). She further notes that "our practices around race have ordered our communities locally and globally with real consequences accorded along queues of privilege and disadvantage. An understanding of race is invariably situated in our everyday lives and inevitably permeates every facet" (p. 91). Most importantly, Johnson-Bailey observes "[o]verwhelmingly, studies and voluminous anecdotal accounts support the existence of differing experiences based on race and

ethnicity: group membership affords entitlements or prohibitions according to racial classifications" (p. 91).

Raver (2007) notes that the question of race and ethnicity has always played a significant role in every facet of American life. According to him, this situation has been the case since the foundation of the United States and race relations continue to be a constant theme in American history. Further, he notes, "As the nation matured, legal pronouncements on the issue of race and its associated social conditions were commonplace, and indeed are still frequent in the twenty-first century" (p. 1). Raver concludes that the idealized traditional view is that the United States Constitution guarantees equal rights for all Americans, regardless of race and other factors, but the historical facts support a different view.

Perna (2000) says that the percentage of students who enrol in college continues to vary by racial and ethnic group. In 1990, only 38 percent of African American and Hispanic high school sophomores (students in the second year) who aspired to attend college eventually enrolled, compared with 55 percent of whites and Asians. The data cited above suggest that African American and Hispanic students seem to be less engaged educationally. Does enjoyment of the learning experience play a role? Do minority students find the college environment welcoming and nurturing? Perna states that "the internalized system of thoughts, beliefs, and perceptions acquired from the immediate environment, conditions an individual's expectations, attitudes, and aspirations" (p. 73).

Race and ethnicity are sometimes used to convey the same meanings and sometimes their use is meant to convey different concepts. For example, in Statistical Directive No. 15 issued by the Federal government's Office of Management and Budget (OMB) on May 12, 1977, the following definitions were given:

- ***Race*:**
  - American Indian or Alaskan Native
  - Asian or Pacific Islander
  - Black
  - White
- ***Ethnicity*:**
  - Hispanic origin
  - Not of Hispanic origin

(*OMB*, 1995)

The terms were further defined as follows:

- ***American Indian or Alaskan Native*:** A person having origins in any of the original peoples of North America, and who maintains cultural identification through tribal affiliations or community recognition.
- ***Asian or Pacific Islander*:** A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands, and Samoa.
- ***Black*:** A person having origins in any of the black racial groups of Africa.
- ***Hispanic*:** A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.
- ***White*:** A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.

(*OMB*, 1995)

The category 'Other' was the option that was made available to respondents completing government forms and other documents who felt that the pre-determined groups did not reflect their racial and/or ethnic origins. It is to be noted that the government directive makes a distinction between race and ethnicity. However, one of the definitions of 'ethnicity' at Dictionary.com is "relating to the classification of mankind into groups, esp. on the basis of racial characteristics" (ethnicity, 2010).

This definition lessens the focus on national origin or cultural background. It is this meaning that the term 'ethnicity' as used throughout the study is intended to convey.

1.4   Questionnaires Used in the Study

The Constructivist Learning Environment Survey (CLES) and a modified version of the Enjoyment of Science Lessons scale of the TOSRA were the two questionnaires used to gather information for use in the study (see Appendix B). Fraser (1998b) states that the CLES was developed to assess the degree to which a particular classroom environment is consistent with constructivist epistemology, which asserts that individuals make sense of the world by actively negotiating and building consensus. The Test of Science-Related Attitudes (TOSRA) is a battery of seven distinctive science-related attitude scales (Fraser, 1981), each designed with the same number of items. Since its development, the TOSRA has been used extensively for the assessment of attitudes. Because each scale measures a particular attitudinal aim, researchers have on occasion selected and even modified a scale for their own use. For the present study, the Enjoyment of Science scale was selected, modified, and used to gather data.

1.4.1   Constructivist Learning Environment Survey (CLES)

The Constructivist Learning Environment Survey (CLES) was the principal data-collecting instrument in this study. It was chosen for my research because of Miami Dade College's philosophy of student centredness described in Section 1.2.

Taylor, Fraser, and White (1994) designed the CLES initially to enable teacher-researchers to monitor their development of constructivist approaches to teaching. Taylor, Fraser and Fisher (1997), citing Treagust, Duit and Fraser (1996), state that the original version of the instrument was based on a theory of constructivism concerned with developing teaching strategies that facilitate students' conceptual development.

The original goal of the CLES was to provide teachers with an efficient way to determine the degree to which their students' perceptions of the classroom learning environment enabled them to reflect on their prior knowledge, develop as autonomous learners, and negotiate their understandings with other students. In other words, the CLES was designed to help educators to gain insight into the classroom from a psychosocial perspective (Taylor, Fraser & Fisher, 1997). It measures students' perceptions of the frequency of occurrence of five key dimensions or scales (Taylor, Fraser & Fisher 1997): Personal Relevance, Shared Control, Critical Voice, Student Negotiation and Uncertainty.

The paradigm has shifted in recent years from the thinking that knowledge exists independently of people's minds to the view that learners are co-constructors of what they know (Taylor, Fraser & Fisher, 1997). In other words, the way in which an individual sees the world is shaped by the particular experiences that he or she has had. Taylor and Campbell-Williams (1993) explain that discourse plays a significant role in the learning process. It is not a relatively passive one-way process but one that is multidirectional and interactive. Vella (2004) notes that learners are no longer seen as empty vessels into which educators can simply deposit

information. The learner distils the information after blending it with his or her own experiences. Taylor, Fraser and Fisher (1997) state:

> Open discourse gives rise to opportunities for students to (1) negotiate with the teacher about the nature of their learning activities, (2) participate in the determination of assessment criteria and undertake self-assessment and peer-assessment, (3) engage in collaborative and open-minded inquiry with fellow students, and (4) participate in reconstructing the social norms of the classroom. (p. 295)

The establishment of the scales of the CLES is in recognition of the importance of the foregoing in constructivist epistemology.

In its current revised version, the CLES contains 30 items altogether, with six items in each of its five scales. The frequency response alternatives for each item are Almost Always, Often, Sometimes, Seldom, and Almost Never (Taylor, Fraser & Fisher, 1997). The Personal Relevance scale assesses the meaningfulness of classroom learning and students' out-of-school experiences. The Uncertainty scale examines whether students have opportunities to understand the evolutionary nature of scientific knowledge. The Critical Voice scale seeks to determine if students are comfortable expressing their opinions in class. The Shared Control scale concerns opportunities for students to participate in making decisions about what they learn and how they are assessed. Finally, the Student Negotiation scale determines if provisions are available in a classroom for students to discuss new ideas among themselves.

Two forms of the CLES – the Actual Form and the Preferred Form – are currently available (Taylor, Dawson & Fraser, 1995). Fraser (1998a) explains that the Actual Form measures the learning environment as the students perceive it while the

Preferred Form, which is concerned with goals and value orientations, measures the students' perceptions of the classroom environment they would ideally like or prefer to see.

According to Taylor, Fraser and Fisher (1997), the effort to revise the instrument stemmed out of concern about the cultural weakness revealed through research on the initial version. It was then tested in the United States and Australia and found to be valid and reliable (Dryden & Fraser, 1996). Other studies in Korea (Kim, Fisher & Fraser, 1999), the United States (Dryden & Fraser, 1998; Nix, Fraser & Ledbetter, 2005; Peiro & Fraser, 2008, Spinner & Fraser, 2005), Australia and Taiwan (Aldridge, Fraser, Taylor & Chen, 2000), and South Africa (Aldridge, Fraser & Sebela, 2004) have also confirmed the validity, reliability, and usefulness of the CLES across diverse cultural horizons. See Section 2.5 for a detailed review of literature relevant to the CLES.

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

Fraser (1981) states that the Test of Science-Related Attitudes (TOSRA) was designed to measure seven science-related attitudes among secondary students. The scales are called Social Implications of Science, Normality of Scientists, Attitudes to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. Each scale measures a different aim. The instrument was developed in response to the need to assess attitudes that science educators in Australia and in other countries agreed were important in furthering the aims of science education.

Each of the seven scales of the TOSRA has ten items and requires the following Likert-type response format: Strongly Agree (SA), Agree (A) Not Sure (N), Disagree (D), and Strongly Disagree (SD). Positively-worded (+) items are scored 5, 4, 3, 2, 1 for SA, A, N, D, SD responses, respectively, and negatively-worded (-) items are reverse-scored. The items with positive and negative wording are not identified in the version administered to respondents and are randomly distributed in the survey. The TOSRA has been cross-validated in numerous studies in Australia, in the United States and in several other countries since its initial validation in 1977 (Fraser, 1981).

A modified version of the Enjoyment of Science Lessons scale from the TOSRA was used in this study. All references to science were changed and were replaced by 'this subject'. The scale was renamed the Enjoyment of Lessons Survey. Additionally, all negatively-worded items were reworded. For example, 'I dislike science lessons' now reads 'I like lessons in this subject' and 'I would enjoy school more if there were no science lessons' is now 'I would enjoy college more if there were more lessons in this subject'. More literature about the TOSRA is reviewed in Section 2.6.

1.5   Specific Research Questions

The questions that follow outline the aim of the research. As in any research, it was important in this study to confirm the validity and reliability of the CLES and TOSRA scales. As such, the first research question was:

Research Question #1

Are the following questionnaires valid and reliable when used with adult learners in an urban two-year college:

    a. Constructivist Learning Environment Survey (CLES)

    b. a modified version of the Enjoyment of Science Lessons scale from Test of Science-Related Attitudes (TOSRA)?

To explore the degree to which the demographic factors of sex, age and ethnicity play a role in the way students perceive and enjoy the learning environment, the second question was:

Research Question #2

Are there differences in learning environment perceptions and student enjoyment according to student:

    a. sex

    b. age

    c. ethnicity?

Finally, to determine whether there were associations between the learning environment and student satisfaction, the third question was:

Research Question #3

Are there associations between the classroom learning environment and the student outcome of satisfaction?

1.6   Significance of the Study

When marketers understand their consumer characteristics, they can make more informed decisions about product development and marketing strategies in order to better direct their advertisements to their target population. Likewise, when educators better understand the perceptions and characteristics of the population that they serve, they are in a better position to devise more effective teaching approaches that can maximize both student satisfaction and achievement.   It is these philosophical underpinnings that form the basis of this research.

One aim was to determine whether the trans-national integrity of the CLES and the TOSRA as effective tools for measuring perceptions and attitudes would be sustained at the tertiary level and in the South Florida setting. No evidence has been found that either the CLES or the TOSRA has been used in a similar academic setting in South Florida. However, both instruments have been used extensively and successfully in classrooms around the world but mainly with students at the primary and secondary levels. Thus, their adequacy in this study would be further proof of their robustness and versatility. Educators wishing to investigate psychosocial elements of the learning environment could employ them with even greater confidence, knowing that their soundness extends beyond national borders, cultures, and educational levels.

Another aim was to investigate whether certain demographic factors influence students' perceptions and attitudes. The study is unique in this regard because it focuses on the learning environment for diverse adult learners at the junior college level. Although several past studies have investigated separately the influence of

student sex, age and ethnicity on learning environment perceptions and enjoyment, none was found to have simultaneously investigated all three independent variables at the tertiary level. The results of this study should therefore provide some evidence to support or refute the assertion that the demographic factors of sex, age and ethnicity can influence the way in which students perceive their learning environments and how they react as a consequence. Knowing the potential impact of each factor in classroom environments could help teachers and educational planners who serve diverse populations to be more sensitive to student needs and thus be able to make more informed pedagogical decisions.

1.7   Overview of Thesis Chapters

Chapter 1 presented background information about the context in which the study was conducted and explained its theoretical underpinnings and the classroom dimensions that were investigated. In addition, it briefly discussed the Constructivist Learning Environment Survey (CLES) and the Test of Science-Related Attitudes (TOSRA) – the learning environment and attitude instruments used to gather the data and investigate the importance of studying sex, age and ethnic differences as determinants of the learning environment. Finally, the chapter described the significance of the study, addressed limitations, and outlined the three research questions which were central to the investigation.

Chapter 2 provides a review of current literature that links the present study to the work of previous researchers who contributed to the field of learning environments. It begins with a review of the theoretical framework of the study and explores the emergence of the field of learning environments and the development of assessment

questionnaires. The chapter also reviews past literature dealing with the way in which sex, age, and ethnicity shape attitudes and learning environment perceptions.

Chapter 3 provides information about the research design of the study. It describes the sample of participants and the method of selection. Sections in the chapter describe the development, modification, and administration of the Constructivist Learning Environment Survey (CLES) and a modified version of the Enjoyment of Science Lessons scale of the Test of Science-Related Attitudes (TOSRA), the two instruments used in study. The chapter concludes with a discussion of data-collection procedures, as well as the methods of data analysis chosen to answer each research question.

Chapter 4 reports analyses and results for each research question. Specifically, it discusses the statistical inferences drawn from the data gathered by addressing issues related to the validity and reliability of the CLES and the TOSRA. The chapter also reports results that were found for the investigation of sex, age and ethnic differences and learning environment perceptions and enjoyment. Finally, the findings of the investigation into whether associations exist between the learning environment and student satisfaction are also presented in Chapter 4.

Chapter 5 presents some closing arguments. It reviews and justifies the reasons for conducting the study, summarizes the main points from each of the previous chapters, summarises the major findings of the study and discusses limitations and implications. Recommendations and suggestions for future research are also offered in this chapter.

Chapter 2

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REVIEW OF RELATED LITERATURE

2.1   Introduction

The aim of the present study was to examine whether there were differences based upon sex, age and ethnicity in the way in which students in college courses perceived their classroom environment and in students' enjoyment of their learning experiences.

The previous chapter outlined the context of the study and presented an overview of the underlying assumptions on which the study was based. It explored aspects of the field of learning environment before providing a rationale for studying sex, age and ethnicity. Finally, it discussed the data collection tools, the research questions, and the significance of the study.

This present chapter reviews literature related to the study and is organized into several sections, each describing a different aspect of the literature review. The first section, Section 2.1, reintroduces the aims and foci of the study. This is followed by Section 2.2, which is devoted to constructivism, the philosophy of learning that underlies the research. The section also reviews literature dealing with student classroom perceptions and attitudes. Historical milestones in the field of learning environments research are presented in Section 2.3. Section 2.4 is an overview of

several questionnaires commonly used for assessing classroom environments. The next two sections focus exclusively on the instruments that were used to collect quantitative data from the sample. Section 2.5 is devoted to the Constructivist Learning Environment Survey (CLES) and Section 2.6 to the Test of Science-Related Attitudes (TOSRA). Literature about sex, age and ethnicity, as determinants of classroom environment, and past research on these determinants are examined in Section 2.7. The chapter ends with a summary, which is presented in Section 2.8.

2.2 Fundamental Assumptions and Rationale: Constructivism

For the purposes of this study, I chose to review literature on constructivism because of the student-centred philosophy of Miami Dade College described in Section 1.2. According to Phillips (2000), "is constructivism a set of views about how students learn (and about how those who help them ought to teach)" (p. 7). Specifically, it promotes the idea that the active participation of students in the construction of their repertoire of knowledge is a more useful teaching approach than one that encourages passive absorption of facts to be regurgitated later. As von Glasersfeld (1989) points out, the acquisition of knowledge is both an 'active' and 'adaptive' process, which means that learners must be fully engaged (p. 162).

Jaworski (1996) points out: "No classroom is an isolated box. It is part of the wider community, which has cultural practices and social norms." Constructivism accommodates that view. It is concerned with who our students are, where they have been, what they have done, why they do what they do, and how they do it. As Jones and Brader-Araje (2002) assert, teachers who consider students' prior knowledge

and preconceptions can design more effective instructional approaches, which is the ultimate goal of my study.

According to Lorsbach and Tobin (1992), within constructivist epistemology, an individual's interaction with the environment helps him or her to build a picture of the world. In the classroom, this interaction influences what the individual sees, thinks, and does in response to his or her perceptions of the environment. In other words, it helps to shape a student's perceptions of his or her classroom environment and subsequently his or her attitude or reactions to it. This view suggests that constructivist theories are relevant in the classroom and are useful to teachers in guiding their practice, but other researchers hold opposing viewpoints.

The purpose of this section is to review literature that delineates views from both sides of the divide. It begins with a brief overview of the historical origins of constructivism and arguments justifying its relevance (Section 2.2.1). This is followed by a subsection on objectivism, the opposing viewpoint (Section 2.2.2). The final subsection reviews contrasting theories about the efficacy of the constructivist teaching approach (Section 2.2.3).

2.2.1   Constructivism: One Point of View

Constructivism, according to Perkins (1992), traces its more recent roots to the works of Jean Piaget, Jerome Bruner, Ulric Neisser, and Nelson Goodman. But, according to Wager (1995), it is not new. It was the underlying philosophy of Dewey in the early 1900s and others who bemoaned the imbalance in the emphasis

placed on "educational objectives" and "expressive objectives" (p. 8). More was being placed on the former than on the latter. Perhaps not as a name but as an idea, constructivism predates even Dewey. According to von Glasersfeld (1990), Giambattista Vico, an eighteenth-century Neopolitan philosopher, made mention of the "construction of knowledge" in a journal circa 1710 (p. 19).

"Central to the vision of constructivism," Perkins (1992) writes, "is the notion of the organism as 'active' – not just responding to stimuli, as in the behaviourist rubric, but engaging, grappling, and seeking to make sense of things" (p. 49). Thus, constructivism is a humanistic rather than an impersonal approach. Building on von Glasersfeld's (1989) theory, Treagust, Duit and Fraser (1996) state that the approach is grounded on two principles: one psychological and the other epistemological. "The first principle," they argue, "states that knowledge is not received passively but is built up by the cognising subject; the second states that the function of cognition is adaptive and enables the learner to construct viable explanations of experiences" (p. 4).

Constructivists do not deny that an outside reality exists, but they argue that it is subject to human interpretation (Duit & Treagust, 1995; Bednar et al., 1992; Duffy & Jonassen, 1992). This perspective puts to rest any notion that there is one best way or a single, unchanging, correct view of reality and instead allows for unlimited, transformative or evolving interpretations. Duit and Treagust (1995) refer to this view as different ways of looking at the same reality, which at times cause misunderstanding.

2.2.2   Objectivism: The Opposing Point of View

The objectivist view of the world is one in which knowledge and instruction exist separately and independently (Duffy & Jonassen, 1992; Taylor, Fraser & Fisher, 1997). More specifically, objectivists believe that the things that exist, their specific characteristics, and the way in which they relate to each other are naturally in harmony. Therefore, they subscribe to the idea that "experience plays an insignificant role in the structuring of the world" (Duffy & Jonassen, 1992, p. 2) and, according to the same authors, further believe that "meaning is something that exists in the world quite aside from experience" (p. 2). This view makes allowance for congruence in what two people understand but faults prior knowledge and individual interpretation for differences in opinions.

Bednar, Cunningham, Duffy and Perry (1992) define objectivism – an aspect of behaviourism – as the school of thought in which knowledge is seen as "some entity existing independently of the mind which is transferred 'inside the mind'" (p. 20). These writers liken this perception to the way computers are constructed and programmed: the hardware is the same for everyone and 'knowledge' is just 'mapped' on. In other words, if two people face the same reality, they will emerge with the same view or as some people would interpret the assertion – one size fits all. There is no room for idiosyncrasies. Bednar et al. further explain that objectivity is the goal of objectivism and that "science can ultimately give a correct, definitive, and general account of reality" (p. 21). Taylor et al. (1997) describe the objectivist's perspective as one that not only views knowledge as existing independently of our

minds but as an entity that is "static and unchanging over time and is the embodiment of universal truths" (p. 295).

According to Cunningham (1992):

> Under objectivism someone decides what it is that the student should know, constructs a task analysis of that knowledge, analyses the learner's existing capabilities, designs a strategy to communicate the required information to the learner, then tests to see if the communication process has been successful. (p. 38)

Further, Jonassen (1992) states: "Objectivists believe in the existence of reliable knowledge about the world. As learners our goal is to gain this knowledge; as educators, to transmit it" (p. 138). He adds that an assumption is then made that "all learners gain the same understanding from what is transmitted." To show learning, learners are then simply expected to regurgitate the 'knowledge' they have 'ingested,' unaffected by the environmental, psychological, and physiological factors and processes from which the learner cannot separate himself or herself. In fact, Gunstone and White (2000) state:

> A typical study of the 1960s would attend to the details of teaching procedures being compared, the tests to measure outcomes, and the statistical analysis of the test scores. It would not attend to the context in which the learning was to occur. It would ignore the feelings of the students for the topic and their prior knowledge of it, their beliefs about the purpose of schooling and about the learning of the topic, and their feelings for each other and the teacher. (p. 295)

The focus of the traditional approach was clearly on the product and not on the process. In an objectivist's classroom, the teacher is seen as an authority figure who presents knowledge to students. Interestingly, objectivism, which is sometimes referred to as the foundational (Taylor et al., 1997), the classic or the traditional

epistemology, according to Duffy and Jonassen (1992), is the foundation of the U.S. instructional system.

2.2.3   *Constructivist Teaching Approach: Pros and the Cons*

Wilson, Teslow and Osman-Jouchoux (1995) suggest that constructivism embraces diversity in thinking while eschewing rationalistic, linear perspectives but that the literature falls short of practical suggestions. They add that constructivism is a way of thinking and not a specific approach. It is adaptable. These same writers then provide a list of advantages and possible risks in using the constructivist model of design. Among the advantages, according to Wilson et al., are the following:

> More meaningful learning outcomes that are likely to be used in relevant contexts; more meaningful participation of the learner in the learning process; more independent problem-solving capability in students; more flexibility in design activities; more flexibility in instructional activities; more acknowledgement of social and motivational factors in learning. (p. 154)

However, Taylor, Fraser and Fisher (1997) caution: "a learning environment undergoing epistemological transformation can be an unsettling experience" (p. 297). Among the risks, according to Wilson et al. (1995), are "more costly instruction, greater need for instructional resources and information management; less coverage of material; less demonstration of a specific skill mastery; and chaos and confusion if poorly implemented" (p. 154).

"Constructivism does not offer pedagogical recipes or convenience" (Davis, Maher & Noddings, 1990, p. 188). Further, they write, "Adopt a constructivist point of view, and you will need to change your expectations of schools, of teachers, of

'content,' of teacher education, and of research methodologies" (p. 190). These writers also mention that teachers' attitudes toward students must change so that relationships of care and trust can develop. When we care, they suggest, we listen. Conceivably, when we listen, we learn. Bednar et al. (1992) observe: "Learning must be situated in a rich context, reflective of real-world contexts for the constructive process to occur and transfer to environments beyond the school or training classroom" (p. 22).

Olson (1995) observes that objectivism and constructivism are not "diametric opposites, but rather positions along a continuum that promote learning" (p. 49). Suggesting that both approaches present opportunities that promote or foster learning, she observes: "Whether or not objectivist or constructivist approaches are used should be determined by the context of the learning experience" (p. 50). Many of the researchers cited earlier would seem to defer with that opinion. They would perhaps argue that people do not live in a vacuum and that as a result learning does not take place in isolation.

The context in which this study was undertaken – a college setting with adult students of both sexes and various ages and ethnicities – is unquestionably a dynamic one where many variables are at play. It gave rise to my idea to explore the determinants and effects of the learning environment in the courses in which the students were enrolled. The approach is consistent with the constructivist epistemology, which recognizes and embraces the plethora of variables that affect the learning environment and encourages the search for ways to enhance learning outcomes through learning environment research. Section 2.3, which follows,

discusses historical milestones in the field of learning environment and highlights a number of questionnaires that have been developed to assess the classroom environment.

2.3   Field of Learning Environment

My study drew from and contributed to the field of learning environment. Lewin (1936) and Murray (1938) are credited with having laid the foundation for present-day classroom environment research. Lewin theorized that an individual's situational circumstances determined his or her behaviour. He expressed this view in his famous formula, $B = f(P, E)$, in which Behaviour (B) is seen as a function f of two interdependent influences, the Person (P) and the Environment (E). Expanding on this concept, Murray developed the needs-press theory, which suggests that the needs of an individual are shaped by the influence (press) of the environment.

Further, Murray (1938) distinguished between what he termed the *alpha press,* the view of the environment as seen through the eyes of a detached external observer, and the *beta press*, the view as seen by an active participant or an insider. Stern, Stein and Bloom (1956) extended this idea by introducing the concept of the *private* beta press – the personal view of the environment – and the *consensual* beta press – the shared view. This was to be a significant pioneering step in classroom environment research as it eventually provided a framework for the multi-dimensional analysis of data from environment scores.

As noted earlier, Lewin's (1936) and Murray's (1938) groundbreaking work outside

the educational setting led to the recognition and documentation of the fact that the

environment strongly influenced an individual's behaviour. Since then, numerous

research efforts in a variety of school settings have consistently established that

students' perceptions of their classroom psychosocial environment influence their

cognitive and affective learning outcomes. Research conducted in Australia by

Fisher and Fraser (1982), McRobbie and Fraser (1993) and Yarrow, Millwater and

Fraser (1997) were among the early studies of associations between the psychosocial

environment and learning outcomes. More recent examples include those conducted

by Henderson, Fisher and Fraser (2000) in Australia, Fraser, Aldridge and Adolphe

(2010) in Indonesia, Fraser and Lee (2009) in Korea, Chionh and Fraser (2009) in

Singapore, Aldridge, Fraser and Sebela (2004) in South Africa and Lightburn and

Fraser (2007) in the USA.

Taylor, Fraser, and Fisher (1997) report the existence of consistent relationships

between the way in which students perceive their learning environment and the way

in which they respond cognitively and affectively. The learning process, clearly,

does not take place in a manner that is bereft of environmental influences. In fact,

Fraser (1986b), in referring to Walberg's (1981) model of educational productivity,

observes the following:

> Psychosocial learning is one factor in [a] multi-factor psychological
> model of educational productivity, which holds that learning is a
> function of student age, ability and motivation; of quality and
> quantity of instruction; and of the psychosocial environments of the
> home, the classroom, the peer group and the mass media. (p. 20)

To underscore the significance of the classroom environment, Fraser (2001) notes

that students spend a considerable amount of time in school classrooms, which he

quantifies to be approximately 15,000 hours by the end of secondary schooling. That chunk of time is almost equivalent to being in one place continuously for one year and nine months. If one were continuously immersed in a target language setting for that amount of time, it would not be unreasonable to expect that, under normal circumstances, one would be proficient in the new language because of the 'environmental' influence.

The way in which students perceive and react to the quality of life in their classroom settings is significant. Fraser (2001) further observes that "teachers concentrate almost exclusively on the assessment of academic achievement and devote little attention to factors which might be related to their students' performance" (p. 1). In doing so, they pay attention only to the actors and the actresses in 'the story' and not to the setting in which the action unfolds. It is in recognition of the existence of this gap in the evaluation process and in an effort to address it that researchers, guided by the notion that student performance is directly and consistently related to their perceptions of the learning environment, fairly recently felt the motivation to take an interest in investigating the impact of various environmental influences on the learning process and develop the means to measure it.

2.3.1   Historical Perspectives

According to Fraser (1998b), pioneering work in the use of classroom environment assessments began in the late 1960s. Working on Harvard Project Physics, Herbert Walberg developed the Learning Environment Inventory (LEI) for use in the research and evaluation activities of the project (Walberg & Anderson, 1968).

According to Fraser (1998b), the Learning Environment Inventory (LEI), in its final version, contains 105 statements – seven per scale – that describe school classes. A four-point Likert scale is used to capture the responses. Moos, on the other hand, pioneered the development of the Classroom Environment Scale (CES), an evolution of his social climate scales, which were geared for use in psychiatric hospitals and correctional institutions (Moos, 1979; Moos & Trickett, 1974). The CES is a nine-scale instrument with 10 true or false items in each scale.

Since the initial development of the LEI and CES several decades ago, many other instruments have been developed to assess students' perceptions of a variety of classroom environments. Fraser (1998a) makes the point that, over time, researchers developed numerous adaptations of these instruments to measure perceptions. Section 2.4 lists an extensive array of those that are of contemporary importance and provides a detailed overview of their development and format, among other things. Fraser (1998b) refers to the development and propagation of these instruments as "remarkable growth, diversification, and internationalization" and more importantly, reports that the instruments have been found to be useful and valid in many countries (p. 1).

2.4 Questionnaires for Assessing Classroom Environments

Although numerous tools to assess classroom environments have been developed over the years, only the nine most widely-recognized ones are directly relevant to the scope of this study and are presented here: Learning Environment Inventory (LEI), Classroom Environment Scale (CES), Individualised Classroom Environment

Questionnaire (ICEQ), My Class Inventory (MCI), College and University Classroom Environment Inventory (CUCEI), Questionnaire on Teacher Interaction (QTI), Science Laboratory Environment Inventory (SLEI), Constructivist Learning Environment Survey (CLES), and What Is Happening In This Classroom? (WIHIC). Table 2.1 names each instrument, shows the education level for which its use is recommended, lists the number of items per scale and classifies the scales according to Moos's (1974a) scheme for classifying human environments.

As indicated in the foregoing paragraph, Moos (1974a) developed the conceptual framework on which the scales of all nine instruments are based. The scheme consists of three dimensions: Relationship Dimensions (which identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support and help each other), Personal Development Dimensions (which assess basic directions along which personal growth and self-enhancement tend to occur) and System Maintenance and Change Dimensions (which involve the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change). Thus, there is some commonality in the design and utility of the instruments.

2.4.1   *Learning Environment Inventory (LEI)*

The initial development and validation of a preliminary version of the LEI began in the late 1960s in conjunction with the evaluation and research related to Harvard Project Physics (Fraser, Anderson & Walberg, 1982; Walberg & Anderson, 1968).

Table 2.1   Overview of Scales Contained in Nine Classroom Environment Instruments (LEI, CES, ICEQ, MCI, CUCEI, QTI, SLEI, CLES and WIHIC)

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

Source: Fraser (1998b)

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The final version contains a total of 105 statements (or seven per scale) descriptive of typical school classes. The respondent expresses the degree of agreement or disagreement with each statement using the four response alternatives of Strongly Disagree, Disagree, Agree and Strongly Agree. The scoring direction (or polarity) is reversed for some items. A typical item in the Cohesiveness scale is: 'All students know each other very well' and in the Speed scale is: 'The pace of the class is rushed'.

2.4.2   Classroom Environment Scale (CES)

The CES was developed by Rudolf Moos at Stanford University (Fisher & Fraser, 1983; Moos 1979; Moos & Trickett, 1987) and grew out of a comprehensive program of research involving perceptual measures of a variety of human environments including psychiatric hospitals, prisons, university residences and work milieus (Moos, 1974b).

The final published version contains nine scales with 10 items of True-False response format in each scale. Published materials include a test manual, a questionnaire, an answer sheet and a transparent hand scoring key. Typical items in the CES are: 'The teacher takes a personal interest in the students' (Teacher Support) and 'There is a clear set of rules for students to follow' (Rule Clarity).

2.4.3   Individualised Classroom Environment Questionnaire (ICEQ)

The ICEQ assesses those dimensions which distinguish individualised classrooms from conventional ones. The initial development of the ICEQ (Rentoul & Fraser,

1979) was guided by: the literature on individualised open and inquiry-based education; extensive interviewing of teachers and secondary school students; and reactions to draft versions sought from selected experts, teachers and junior high school students. The final published version of the ICEQ (Fraser, 1990) contains 50 items altogether, with an equal number of items belonging to each of the five scales.

Each item of the ICEQ is responded to on a five-point scale with the alternatives of Almost Never, Seldom, Sometimes, Often and Very Often. The scoring direction is reversed for many of the items. Typical items are: 'The teacher considers students' feelings' (Personalisation) and 'Different students use different books, equipment and materials' (Differentiation). The published version has a progressive copyright arrangement which gives permission to purchasers to make an unlimited number of copies of the questionnaires and response sheets.

2.4.4   *My Class Inventory (MCI)*

The LEI has been simplified to form the MCI for use among children aged 8–12 years (Fisher & Fraser, 1981; Fraser, Anderson & Walberg, 1982; Fraser & O'Brien, 1985). Although the MCI was developed originally for use at the primary school level, it also has been found to be very useful with students in the junior high school, especially those who might experience reading difficulties with other instruments. The MCI differs from the LEI in four important ways. First, in order to minimise fatigue among younger children, the MCI contains only five of the LEI's original 15 scales. Second, item wording has been simplified to enhance readability. Third, the LEI's four-point response format has been reduced to a two-point (Yes–No)

response format. Fourth, students answer on the questionnaire itself instead of on a separate response sheet to avoid errors in transferring responses from one place to another. The final form of the MCI contains 38 items altogether, with typical items being: 'Children are always fighting with each other' (Friction) and 'Children seem to like the class' (Satisfaction). Although the MCI traditionally has been used with a Yes–No response format, Goh, Young and Fraser (1995) have successfully used a three-point response format (Seldom, Sometimes and Most of the Time) with a modified version of the MCI which includes a Task Orientation scale.

More recent studies using the MCI include Majeed, Fraser and Aldridge (2002), who used it in Brunei Darussalam to assess perceptions of classroom learning environments among lower secondary school students in mathematics classes. Additionally, Houston, Fraser and Ledbetter (2008) used the MCI in the USA to assess whether the use of science kits, textbooks, or a combination of both, along with teacher-created aids led to a more positive teaching environment. Two other studies in the USA also used the MCI. Mink and Fraser (2005) used it to evaluate a primary school mathematics program and Sink and Spencer (2007) used it with elementary school counsellors to evaluate aspects of their school's counselling program. All of these studies supported the validity and usefulness of the MCI.

2.4.5   College and University Classroom Environment Inventory (CUCEI)

Although some notable prior work has focused on the institutional-level or school-level environment in colleges and universities (e.g., Halpin & Croft, 1963; Stern, 1970), surprisingly little work has been done in higher education classrooms which

is parallel to the traditions of classroom environment research at the secondary and primary school levels. Consequently, the CUCEI was developed for use in small classes (say up to 30 students) sometimes referred to as 'seminars' (Fraser & Treagust, 1986; Fraser, Treagust & Dennis, 1986). The final form of the CUCEI contains seven seven-item scales. Each item has four responses (Strongly Agree, Agree, Disagree, Strongly Disagree) and the polarity is reversed for approximately half of the items. Typical items are: 'Activities in this class are clearly and carefully planned' (Task Orientation) and 'Teaching approaches allow students to proceed at their own pace' (Individualisation).

2.4.6   Questionnaire on Teacher Interaction (QTI)

Research which originated in The Netherlands focuses on the nature and quality of interpersonal relationships between teachers and students (Creton, Hermans & Wubbels, 1990; Wubbels, Brekelmans & Hooymayers, 1991; Wubbels & Levy, 1993). Drawing upon a theoretical model of proximity (cooperation-opposition) and influence (dominance-submission), the QTI was developed to assess student perceptions of eight behaviour aspects. Each item has a five-point response scale ranging from Never to Always. Typical items are 'She/he gives us a lot of free time' (Student Responsibility and Freedom behaviour) and 'She/he gets angry' (Admonishing behaviour).

Although research with the QTI began at the senior high school level in The Netherlands, cross-validation and comparative work has been completed at various grade levels in the USA (Wubbels & Levy, 1993), Australia (Fisher, Henderson &

Fraser, 1995), Singapore (Goh & Fraser, 1996), Brunei (Riah, Fraser & Rickards, 1997) and India (Koul & Fisher, 2005). Goh and Fraser (1996) developed and validated a more economical 48-item version of the QTI, and Fisher and Cresswell (1998) modified the QTI to form the Principal Interaction Questionnaire (PIQ) which assesses teachers' or principals' perceptions of the same eight dimensions of a principal's interaction with teachers.

2.4.7   Science Laboratory Environment Inventory (SLEI)

Because of the critical importance and uniqueness of laboratory settings in science education, an instrument specifically suited to assessing the environment of science laboratory classes at the senior high school or higher education levels was developed (Fraser, Giddings & McRobbie, 1995; Fraser & McRobbie, 1995; Fraser, McRobbie & Giddings, 1993). The SLEI has five scales (each with seven items) and the five response alternatives are Almost Never, Seldom, Sometimes, Often and Very Often. Typical items are 'I use the theory from my regular science class sessions during laboratory activities' (Integration) and 'We know the results that we are supposed to get before we commence a laboratory activity' (Open-Endedness). The Open-Endedness scale was included because of the importance of open-ended laboratory activities often claimed in the literature (e.g., Hodson, 1988).

The SLEI was field tested and validated simultaneously with a sample of over 5,447 students in 269 classes in six different countries (the USA, Canada, England, Israel, Australia and Nigeria), and cross-validated with 1,594 Australian students in 92 classes (Fraser & McRobbie, 1995), 489 senior high school biology students in

Australia (Fisher, Henderson & Fraser, 1997) and 1,592 grade 10 chemistry students in Singapore (Wong & Fraser, 1996).

In more recent studies using the SLEI, Henderson, Fisher and Fraser (2000) explored associations between laboratory environments and student outcomes in biology classes in Australia, and Quek, Wong and Fraser (2005) studied gifted and non-gifted year 10 students in chemistry classes in Singapore. Hofstein, Nahum and Shore (2001) assessed students' perceptions of chemistry laboratory learning environment in Israel. Fraser and Lee (2009), using a Korean language version, assessed laboratory classroom environments in Korea. Finally, in the USA, Lightburn and Fraser (2007) used the SLEI to assess the classroom environment among high school biology students, while Martin-Dunlop and Fraser (2008) selected SLEI scales for assessing students' perceptions of laboratory learning environments. In each of these cases, the SLEI was found to be a valid and reliable instrument for measuring student perceptions.

2.4.8 *Constructivist Learning Environment Survey (CLES)*

According to the constructivist view, meaningful learning is a cognitive process in which individuals make sense of the world in relation to the knowledge which they already have constructed, and this sense-making process involves active negotiation and consensus building. The CLES (Taylor, Dawson & Fraser, 1995; Taylor, Fraser & Fisher, 1997) was developed to assist researchers and teachers to assess the degree to which a particular classroom's environment is consistent with a constructivist epistemology and to assist teachers to reflect on their epistemological

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assumptions and reshape their teaching practice. Appendix A contains a complete copy of the CLES's 'Actual' Form. (Section 1.4.1 in Chapter 1 provided clarification of the distinction between the 'Actual' and 'Preferred' Forms.) Studies that have successfully used the CLES include Aldridge, Fraser, Taylor and Chen (2000) in Taiwan and Australia, Aldridge, Fraser and Sebela (2004) in South Africa, Kim, Fisher and Fraser (1999) in Korea and Peiro and Fraser (2008), Nix, Fraser and Ledbetter (2005) and Roth and Roychoudhury (1994) in the USA. A more extensive exploration of past research using the CLES follows in Sections 2.5 and 2.6.

2.4.9   What Is Happening In this Class? (WIHIC)

The WIHIC questionnaire brings parsimony to the field of learning environment by combining modified versions of the most salient scales from a wide range of existing questionnaires with additional scales that accommodate contemporary educational concerns (e.g., equity and constructivism). Also, the WIHIC has 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 original 90-item nine-scale version was refined by both statistical analysis of data from 355 junior high school science students, and extensive interviewing of students about their views of their classroom environments in general, the wording and salience of individual items and their questionnaire responses (Fraser, Fisher & McRobbie, 1996). Only 54 items in seven scales survived these procedures, although this set of items was expanded to 80 items in eight scales for the field

testing of the second version of the WIHIC, which involved junior high school science classes in Australia and Taiwan. Whereas the Australian sample of 1,081 students in 50 classes responded to the original English version, a Taiwanese sample of 1,879 students in 50 classes responded to a Chinese version that had undergone careful procedures of translation and back translation (Aldridge, Fraser & Huang, 1999). This led to a final form of the WIHIC containing the seven eight-item scales. More recently, the WIHIC has proved to be valid and reliable in studies of high school chemistry classes in Singapore (Chionh & Fraser, 2009) and Brunei (Riah & Fraser, 1998), in high school mathematics classes in Australia (Dorman, 2001), in technology, mathematics and science classes in Canada (Raaflaub & Fraser, 2002; Zandvliet & Fraser, 2004), among private university students in Indonesia (Margianti, Aldridge & Fraser, 2004), in science classes in co-educational private schools in India (Koul & Fisher, 2005), among teachers in South Africa (Aldridge, Laugksch, & Fraser, 2006) and in a variety of institutions and with a variety of samples from the USA (Allen & Fraser, 2007; Wolf & Fraser, 2008; Pickett & Fraser, 2009). In each case, the WIHIC was reported to have been used successfully.

Researchers have also used the WIHIC in cross-national studies in Britain, Canada and USA (Dorman, 2003) and in Australia and Indonesia (Fraser, Aldridge & Adolphe, 2010). Additionally, the WIHIC has been translated into Chinese for use in Taiwan (Aldridge & Fraser, 2000) and into Korean for use in Korea (Kim, Fisher, & Fraser, 2000). Dorman (2003) found that the items of the WIHIC usually have factor loadings above 0.40 on their *a priori* scales and lower loadings on other scales and that the factor structure has been invariant across grade levels, countries,

cultures and gender, thereby suggesting the usefulness of the instrument in studying multicultural and heterogeneous school populations.

2.5   Constructivist Learning Environment Survey (CLES)

One of the aims of this research was to test the validity and reliability of the Constructivist Learning Environment Survey (CLES). This instrument was chosen because of its relevance and because, in many past studies conducted around the world, it has proved to be a powerful tool in detecting significant differences or relationships occurring in the populations under study. This section traces the development of the questionnaire and reviews its use in a number of important learning environment studies undertaken in different academic settings in several countries.

Taylor, Fraser and White (1994) report that they initially designed the CLES to enable teacher-researchers to monitor their development of constructivist approaches to teaching. Taylor, Fraser and Fisher (1997) state that the original version of the instrument was based on a theory of constructivism that is concerned with developing teaching strategies that facilitate students' conceptual development. These researchers add that "this conceptual change research highlights (1) the key role of students' prior knowledge in their development of new conceptual understandings, and (2) the reflective process on interpersonal negotiation on meaning within the consensual domain of the classroom community" (p. 29).

The original goal of the CLES was to provide teachers with an efficient way to determine the degree to which their students' perceptions of the classroom learning environment enabled them to reflect on their prior knowledge, develop as autonomous learners, and negotiate their understandings with other students. More specifically, the CLES was developed with two reasons in mind. First, it was to assist researchers to assess the degree to which a particular classroom's environment is consistent with a constructivist epistemology. Second, it was intended to help them to reflect on their epistemological assumptions and reshape their teaching practice (Fraser, 1998b). Put another way, the CLES was designed to help educators gain insight into the classroom from a psychosocial perspective (Taylor, Fraser & Fisher, 1997).

The CLES is designed to measure students' perceptions of the frequency of occurrence of five key dimensions or scales (Taylor, Fraser & Fisher, 1997). They argue that "the original version … remained blind to the cultural context framing the classroom environment" (p. 293). As a result, the instrument was redesigned to expand its scope so that it would capture the impact of more variables and thus offer a broader, more comprehensive view of constructivism in the classroom environment (see Appendix C).

Below are the scale labels and a sentence to explain the classroom dimension that each scale seeks to assess.

- Personal Relevance – This scale focuses on the connectedness of school science to students' out-of-school experiences, and with making use of

students' everyday experiences as a meaningful context for the development of students' scientific and mathematical knowledge.

- Uncertainty – This scale assesses the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory-dependent inquiry involving human experience and values, and as evolving, non-foundational, and culturally and socially determined.

- Critical Voice – This scale examines the extent to which a social climate has been established in which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods and to express concerns about any impediments to their learning.

- Shared Control – This scale is concerned with students being invited to share with the teacher control of the learning environment, including the articulation of learning goals, the design and management of learning activities, and the determination and application of assessment criteria.

- Student Negotiation – This scale assesses the extent to which opportunities exist for students to explain and justify to other students their newly developing ideas, to listen attentively and reflect on the viability of other students' ideas and, subsequently, to reflect self-critically on the viability of their own ideas.

In its current revised form, the CLES contains 30 items altogether, with six items in each of its five scales. The frequency response alternatives for each item are Almost Always, Often, Sometimes, Seldom, and Almost Never (Taylor, Fraser & Fisher, 1997). Taylor, Fraser and Fisher (1997) maintain that "each CLES scale assesses a unique aspect of constructivism within the classroom environment" (p. 298). Also,

the CLES was found to be valid and reliable for use across diverse cultural horizons in studies in Australia and Taiwan (Aldridge, Fraser, Taylor & Chen, 2000; Taylor, Dawson & Fraser, 1995), the United States (Dryden & Fraser, 1998; Nix, Fraser & Ledbetter, 2005; Peiro & Fraser, 2008; Spinner & Fraser, 2005), Korea (Kim, Fisher & Fraser, 1999) and South Africa (Aldridge, Fraser & Sebela, 2004).

In a study designed to monitor the development of constructivist learning environments in intermediate and senior schools in South Africa, Aldridge, Fraser, and Sebela (2004) administered a preferred and actual version of the CLES among 1,864 students in 43 schools in six schools. As in previous studies in countries outside Australia, the instrument underwent slight modification in order to ensure its suitability for South African settings. Principal components factor analysis with varimax rotation confirmed the *a priori* structure of the CLES. Cronbach's alpha coefficient was calculated to establish that scale reliability estimates compared favourably with the 0.70 threshold that Nunnally and Bernstein (1994) regard as acceptable. Factor analysis attested to the independence of CLES scales, whereas an analysis of variance (ANOVA) was used to determine that the learners perceived the learning environment in the different mathematics classes differently for each CLES scale.

Using data from a study involving a sample of approximately 1,600 students in 120 Grades 9–12 science classes in Dallas, Texas, Dryden and Fraser (1998) used Cronbach's alpha coefficient to reveal high internal consistency reliability values ranging from 0.61 to 0.89 for different CLES scales. A principal components factor analysis was performed on the data to confirm the *a priori* structure of the CLES

scales. The study involved evaluating the impact of a reform initiative, the Urban Systemic Initiative, which encouraged a more constructivist approach in high school science instruction.

Nix, Fraser and Ledbetter (2005) reported the validity and reliability of a modified version of the CLES, the CLES-CS, or the comparative student version. Students were asked to compare the degree to which they felt that the principles of constructivism had been implemented in the classes taught by teachers of the Integrated Science Learning Environment program with all of their other teachers. The researchers collected data from 1,079 students in 59 classes in north Texas. Principal components factor analysis with varimax rotation and Kaiser normalization confirmed the *a priori* structure of the CLES-CS, and its internal consistency reliability, discriminant validity, and the ability to distinguish between different classes and groups were also supported.

In a study into whether an innovative mathematics program provided elementary students in Miami-Dade County in Florida with an improved classroom environment, attitudes, and conceptual development compared to those studying a traditional program, Spinner and Fraser (2005), using the CLES along with two other instruments – the Individualized Classroom Environment Questionnaire (ICEQ) and the Test of Mathematics-Related Attitude (TOMRA) – found Cronbach's alpha reliability coefficient for CLES scales ranging from 0.53 to 0.86 and 0.76 to 0.87 for Sample 1 ($N = 53$) and Sample 2 ($N = 66$), respectively. The mean correlation for the CLES for the first sample ranged from 0.20 to 0.49 and for

the second sample from 0.62 to 0.74. These data provided support for the discriminant validity for the scales of the CLES.

Table 2.2   **Name and Description of Each Scale of the Current Version of the Constructivist Learning Environment Survey (CLES)**

Scale	Description
Personal Relevance	This scale focuses on the connectedness of school science to students' out-of-school experiences, and with making use of students' everyday experiences as a meaningful context for the development of students' scientific and mathematical knowledge.
Uncertainty	This scale assesses the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory-dependent inquiry involving human experience and values, and as evolving, non-foundational, and culturally and socially determined.
Critical Voice	This scale examines the extent to which a social climate has been established in which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods, and to express concerns about any impediments to their learning.
Shared Control	This scale is concerned with students being invited to share with the teacher control of the learning environment, including the articulation of learning goals, the design and management of learning activities, and the determination and application of assessment criteria.
Student Negotiation	This scale assesses the extent to which opportunities exist for students to explain and justify to other students their newly developing ideas, to listen attentively and reflect on the viability of other students' ideas and, subsequently, to reflect self-critically on the viability of their own ideas.

Source: Taylor, Fraser & Fisher (1997)

After undergoing various statistical analyses in numerous studies undertaken in many countries and in many different institutions over many years, the CLES has proved to have satisfactory internal consistency and factorial validity, attesting to its

ability to measure levels of constructivism or the recognition of the ability of students to co-construct knowledge in diverse classroom environments wherever they might be.

Especially because constructivism focuses on the whole person and not just on a select aspect of his or her existence, the CLES is an appropriate instrument to measure how learners perceive their environment. An understanding of the dynamics of the classroom is invaluable to educators as they consider ways to support student learning and encourage best teaching practices. Because its validity has been established in all previous studies, I felt I could use it with confidence for my study.

2.6   Assessment of Attitudes: Test of Science-Related Attitudes (TOSRA)

For the first research question concerning the questionnaires used to collect data for this study, it was important to confirm the validity and reliability of the modified scale of TOSRA used. This instrument was selected to assess student attitudes, one of the aims of the study. The ease of use, versatility and adaptability of TOSRA's scales, as well as its long-established consistency, reliability and validity demonstrated in studies in numerous countries made it suitable for use in this study.

Koballa (2010) defines attitude as "a predisposition to respond positively or negatively toward things, people, places, events, and ideas" (p. 1). He cites the Latin *affectus*, meaning 'feelings' as the etymological origin of the word 'affective' and hence the term affective domain, which is associated with attitude. Since Noll (1935) investigated the measurement of scientific attitudes and Mead and Metraux (1957) reported findings about high school students' perceptions of scientists,

researchers have shown a growing interest in assessing students' affective dimensions. This study continues that tradition as one of its objectives was to determine whether there were associations between the learning environment and student satisfaction – an outcome related to the affective domain.

Schibeci (1982) notes that there are several methods to assess attitudes. Citing Gardner (1975), he mentions differential scales (Thurstone, 1928), rating scales, summated rating scales, semantic differential scales, interest inventories, preference rankings, projective techniques, enrolment data, and anthropological observation. The most commonly used is the summated rating method, or the Likert scale. Schibeci cites Fraser's (1978) Test of Science-Related Attitudes (TOSRA) as an example of a summated rating method. Collins, Reiss and Simon (2006) mention that TOSRA has been the most frequently used instrument to assess attitudes to science, a fact that "may be partly attributable to its multidimensional nature and apparently sound conceptual basis" (p. 12).

As indicated earlier in Section 1.4.2, the original Test of Science-Related Attitudes (TOSRA) questionnaire consisting of 70 items was designed to measure seven distinct science-related attitudes among secondary school students (Fraser, 1978). It is based on Klopfer's (1971) comprehensive classification scheme for science education aims. This Likert-type questionnaire requires subjects to indicate their responses to statements by marking one item on a five-level scale – a variation of which is as follows:

1. Strongly Disagree

2. Disagree

3. Not Sure

4. Agree

5. Strongly Agree

Since the development of the TOSRA, numerous studies using the original instrument or some modified version of it have been done in various countries around the world. One important reason for its widespread use is the fact that, unlike many other attitude tests, TOSRA yields a separate score for a number of distinct attitudinal aims instead of a single overall score. This section reviews several previous studies in which the TOSRA was used to assess attitudes. Included are some in which differences in attitudes on the basis of sex, age and ethnicity were investigated.

Table 2.3   Name and Classification of Each Scale in Test of Science-Related Attitudes (TOSRA)

Scale Name	Klopfer (1971) Classification	
Social Implications of Science (S)	H.1:	Manifestation of favourable attitudes towards science and scientists
Normality of Scientists (N)		
Attitude to Scientific Inquiry (I)	H.2:	Acceptance of scientific inquiry as a way of thought
Adoption of Scientific Attitudes (A)	H.3:	Adoption of 'scientific attitudes'
Enjoyment of Science Lessons (E)	H.4:	Enjoyment of science learning experiences
Leisure Interest in Science (L)	H.5:	Development of interests in science and science-related activities
Career Interest in Science (C)	H.6:	Development of interest in pursuing a career in science

Source: Fraser (1978)

In a study comprising 3,215 students in 158 lower secondary science classrooms in 43 schools in Tasmania and Western Australia, two Australian states, Rickards (1998) used the TOSRA, along with other questionnaires, to examine the relationship of teacher-student interpersonal behaviour with student sex, cultural background and student outcomes. Among other things, the study found that student achievement and student attitude to class were positively associated with teacher-student interpersonal behaviour.

Similarly, in a study undertaken in Korea, Fraser and Lee (2009) used the TOSRA to investigate the association between students' attitude towards science and their perceptions of their classroom environments. Students from three academic streams were involved in the study. Ninety-nine students were from the science-independent stream, 195 students were from the science-oriented stream and 145 students were from the humanities stream. Simple and multiple correlation analyses were utilized to investigate associations between classroom environment and students' attitudes towards science.

Fraser and Lee's (2009) study revealed associations between students' attitudes and their learning environments. First, students' attitudes to science were more positive in classes where students perceive greater emphasis on notions of constructivism. Second, students' attitudes to science were more positive in laboratory classes where students perceive their laboratory lessons more favourably. Third, students' attitudes to science were more positive in classes where students more frequently perceive teachers as exhibiting more cooperative behaviour and less obliging behaviour.

In the USA, Bull (2001) used a scale of the TOSRA, in conjunction with the WIHIC, to establish that student attitudes were positively associated with students' perceptions of their classroom environment. The sample consisted of 1,720 students of different gender, racial, socio-economic and ethnic backgrounds from 65 eighth-grade classrooms in 11 schools in California. In another U.S. study, Robinson (2003) explored associations between student achievement and attitudes toward science and the nature of their classroom learning environment. The study involved a sample of 172 kindergarteners from six classes. The ethnic make-up for this group of 172 students was 11.8% White, 49% Black, 33.6% Hispanic, and 5.6% of other ethnicities. The gender breakdown was 40.4% boys and 59.6% girls. Approximately 45% of the kindergarten student population was made up of English Speakers of Other Languages (ESOL) students. Modified versions of the WIHIC and TOSRA in English and Spanish were used. A major finding of the study was that statistically significant associations existed between kindergarten students' perceptions of their classroom environment and their attitudes toward science.

Aldridge, Fraser and Ntuli (2009) also used a modified form of the TOSRA to assess students' attitudes towards their mathematics classroom as part of study that was designed to examine the viability of using feedback from a learning environment instrument to guide improvements in the teaching practices of in-service teachers undertaking a distance education teacher training program in South Africa. The sample consisted of a group of 31 teachers studying a distance education course and their 1,077 students. The results suggested a link between students' perceptions of the learning environment and their attitudes towards their mathematics classes. Based on the results, teachers soon saw improved students' attitudes towards their

mathematics class after they provided the students with opportunities to work in small groups and to discuss their ideas and understandings with each other.

Lowe's (2004) thesis focused on the effect of cooperative group work and assessment on the attitudes of 312 science students in four rural secondary schools in New Zealand. The students' attitudes were assessed quantitatively using the TOSRA while qualitative results were obtained through teacher and student interviews along with researcher observations. The data were collected before and after three terms of cooperative learning in a variety of activities including practical classes, fieldwork, and written assignments and class tests. The study revealed that group work and group assessment enhanced students' attitudes to science, with both the teachers and students seeing real value in such activities, especially the formative group testing opportunities. The study also confirmed the reliability and validity of the TOSRA in New Zealand schools for the first time. The TOSRA was also used to make comparisons of the science-related attitudes of several subgroups within the study population.

In Thailand, Chantavong (2005) designed a study, among other purposes, to gauge students' attitudes towards statistics using an abbreviated version of the TOSRA and to investigate associations between students' learning environments, their attitudes towards statistics as a subject and their cognitive achievement scores. The QTI and CUCEI were also used. A mainly quantitative study, the sample consisted of 1,285 students in statistics classes. The TOSRA's scale of Attitude Towards Subject was administered to all students after they completed both the QTI and CUCEI. For the Attitude Towards Subject scale in the TOSRA, the Cronbach's alpha reliability

coefficients were 0.84 and 0.86 respectively for individual students. Simple and multiple correlation and regression analyses revealed reasonably strong and positive associations between each of the classroom learning environment scales and students' attitude towards statistics and cognitive achievement scores.

Using the Chemistry Laboratory Environment Inventory (CLEI, a modified version of the SLEI), the Questionnaire on Teacher Interaction (QTI) and a 30-item version of the Questionnaire on Chemistry-Related Attitudes (QOCRA, a modified version of TOSRA), Quek, Wong and Fraser (2005) investigated the impact of the chemistry laboratory environment and teacher-student interaction on student attitudes towards chemistry among 200 gifted secondary-school students in Singapore. They reported associations between the nature of the laboratory classroom environment and students' attitudes towards chemistry and between the interpersonal behaviour of the chemistry teachers and students' attitudes towards chemistry.

Finally, Fraser, Aldridge and Adolphe (2010), in a cross-national study of classroom environments in Australia and Indonesia, used a modified version of the What Is Happening In this Class? (WIHIC) and TOSRA simultaneously in both countries to cross-validate the questionnaires, to investigate sex differences in students' perceptions of their classroom environments and to investigate associations between students' attitudes to science and their perceptions of classroom environment. The sample consisted of 1,161 students (594 students from 18 classes in Indonesia and 567 students from 18 classes in Australia). Simple correlation and multiple regression analyses revealed generally positive associations between the classroom environment and student attitudes to science in both countries.

As shown above, in study after study and even with some modifications, the TOSRA has proved to be valid and reliable for assessing students' attitudes to their classrooms. It has further been shown that the questionnaire can be used with confidence with students in a wide variety of settings.

2.7 Determinants of Classroom Environment and Past Research on Sex, Age and Ethnic Differences Among Students

One aim of the present study was to investigate whether there are differences based on sex, age and ethnicity in the way in which students perceive and enjoy the learning environment. This section presents an overview of some determinants of classroom environment in Section 2.7.1, discusses past research on sex differences in Section 2.7.2, reviews past research on age differences in Section 2.7.3 and reports past research on ethnic differences in Section 2.7.4.

2.7.1 Determinants of Classroom Environment

It has long been established through research that the psychosocial environment in school learning is important. Fraser (1994) identified a number of factors or influences in the psychosocial learning environment that have been investigated in studies using classroom environment instruments. Among them are teacher personality, class size, grade level, subject matter, the nature of the school-level environment, the type of school, ethnic, linguistic and cultural differences, as well as age and sex differences. In still other studies, additional classroom dimensions were explored.

Anderson and Walberg (1972), for example, found that larger class sizes were associated with greater classroom Formality and less Cohesiveness. Kent and Fisher (1997) established associations between teacher personality and classroom environment (e.g., extravert teachers' classes having high levels of Student Cohesiveness). Knight (1992) reported differences in the classroom environment perceptions of African-American and Hispanic students, and Levy, Wubbels, Brekelmans and Morganfield (1997) reported cultural differences (based on place of birth and primary language spoken at home) in student perceptions of teacher-student interaction.

In a study of students' preferences for different types of classroom environments, for example, girls were found to prefer cooperation more than boys, but boys preferred both competition and individualisation more than girls (Owens & Straton, 1980). Similarly, Byrne, Hattie and Fraser (1986) found that boys preferred friction, competitiveness and differentiation more than girls, whereas girls preferred teacher structure, personalization and participation more than boys. Several studies have revealed that females generally hold perceptions of their classroom environments that are somewhat more favourable than the perceptions of males in the same classes (Fisher, Fraser & Rickards, 1997; Fraser, Giddings & McRobbie, 1995; Henderson, Fisher & Fraser, 1995).

Because sex, age and ethnicity were the specific determinants on which this study focused, a review of related literature on past research on each factor is presented in the succeeding subsections.

2.7.2   Sex Differences

Studies of sex differences in classroom environment perceptions in a variety of educational and cultural contexts are well established. For example, in a recent Australian study, Ly's (2008) use of a modified version of the What Is Happening In this Class? (WIHIC) revealed that females had higher scores than males in their geometry classroom learning environment for most scales.

Using the Questionnaire on Teacher Interaction (QTI) and the What Is Happening In this Class? (WIHIC), Khine (2001) investigated the nature of the science learning environment in secondary schools in Brunei. The subjects were 1,188 Form 5 students in 54 classrooms. One of the purposes of the study was to look into sex differences in students' perceptions of their classroom environment. Sex differences in students' perceptions of interpersonal teacher behaviour and classroom environment were found.   Similarly, a study that was carried out in six primary schools in Singapore, comprising a total of 1,401 students from Primary 5 and 6, and 34 teachers in 34 classrooms, Soh (2008), using the primary version of the Questionnaire on Teacher Interaction (QTI), found gender differences in students' perceptions of teacher-student interpersonal behaviour.

In the USA, Ogbuehi and Fraser (2007) conducted a study among 661 middle-school students from 22 classrooms in four inner city schools in California. They used a modified version of the Actual Form of the Constructivist Learning Environment Survey (CLES), the What Is Happening In this Class? (WIHIC), and the Test of Mathematics-Related Attitudes (TOMRA). One purpose of the study was to

investigate sex differences in students' perceptions of classroom environment and attitudes to mathematics. A small but statistically significant difference was found between the genders for Student Negotiation and Task Orientation on the CLES. Female students perceived their mathematics classrooms somewhat more positively than did the male students. There was no statistically significant difference between the sexes on achievement and students' attitudes to mathematics.

In another U.S. study, Eccles (2006) used the Questionnaire on Teacher Interaction (QTI) to compare classroom perceptions and achievement of 1,228 male and female students in Grades 6, 7 and 8 science classes at one middle school in South Florida. Multivariate analysis of variance revealed gender differences in students' perceptions of teacher interpersonal behaviour, attitudes towards science, and science achievement. However, the differences between males and females were statistically significant only for the Helping/Friendly, Dissatisfied, and Admonishing scales of the QTI and for achievement. In general, relative to males, female students had more positive perceptions of teacher interpersonal behaviour and higher academic achievement.

Sex differences in classroom environment perceptions have been explored by numerous other researchers. For example, Fraser, Giddings and McRobbie (1995) in Australia and Goh, Young and Fraser (1995) in Singapore found that girls perceived their classroom environments more favourably than boys did. Majeed, Fraser and Aldridge (2002) also reported similar findings in Brunei, but Fraser, Aldridge and Adolphe (2010) reported that boys perceived some aspects of their learning environment more favourably than girls did in Indonesia.

2.7.3 Age Differences

Unlike sex or gender differences, age differences do not seem to appear too frequently in the literature on learning environment perceptions. When the issue of age arises, it generally has been in the form of grade-level differences. Waxman and Huang (1998) investigated grade-level differences as one of the determinants of students' perceptions of their classroom learning environment among over 13,000 students from 96 urban elementary, middle, and high schools that served predominantly minority students. Using a modified version of the Classroom Environment Scale (CES) and the Instructional Learning Environment Questionnaire (ILEQ), they found that there were many statistically and educationally significant differences by grade level. In general, students in middle school classes had less favourable perceptions of their learning environment than did their counterparts in either elementary or high school classes.

In a study of variables associated with differences in students' perceptions of interpersonal teacher behaviour, Levy, den Brok, Wubbels, and Brekelmans (2003) used the Questionnaire on Teacher Interaction (QTI) to survey 3,023 students and 74 teachers in 168 classes in seven secondary schools (five high schools, two middle schools) in the Washington DC metropolitan area. Several variables were significantly related to students' perceptions: student and teacher sex, student and teacher ethnic background, student age and grade, class size, grade level, subject taught and teacher experience. In particular, age was found to be related to perceptions. Older students felt that their teachers were stricter than did their younger classmates.

According to Levy, den Brok, Wubbels and Brekelmans (2003), students' age occasionally has been found to be significantly related to their perceptions of teachers. Levy, Wubbels, Brekelmans and Morganfield (1997) found that older students noted more teacher dominance than their younger peers, though no effect was found with respect to proximity. However, in a previous study, Levy, Wubbels and Brekelmans (1992) found that student age was unrelated to either influence or proximity.

More recently, Castillo (2007) used the What Is Happening In this Class? (WIHIC) and the Test of Mathematics-Related Attitudes (TOMRA) to investigate factors (grade level, gender and ethnicity) that might affect the attitudes and learning environment perceptions of 600 Grade 9 and 10 mathematics students in 30 classes in one senior high school located in the Kendall area of Miami-Dade County, Florida. Statistical analysis of the data revealed some educationally noteworthy grade-level differences. For instance, increases were found in Student Cohesiveness, Attitude to Inquiry, and Equity scores between Grades 9 and 10. Furthermore, declines between Grades 9 and 10 were found for Teacher Support, Task Orientation and Student Self-Efficacy.

Finally, in a study using a questionnaire modelled after the What Is Happening In this Class? (WIHIC) to assess students' perception of the learning environment and the Test of Science-related Attitudes (TOSRA) to investigate student satisfaction with their course, Khoo and Fraser (2008) found that 250 working adults attending courses in five computer education centres in Singapore generally perceived their learning environments favourably in terms of the levels of Trainer Support, Task

Orientation and Equity. There was little variation either between males and females or between younger and older students (with the main exception being that males perceived more Trainer Support and Involvement, while females perceived lower levels of Equity). However, student satisfaction varied between the sexes and between students of different ages.

2.7.4   Ethnic Differences

Ethnicity, race, minorities and cultural background are some of the terms researchers use to refer to seemingly the same construct: the existence of some perceivable physical or conceptual distinction or social factors that ascribe status to or categorize members of a given population. Many studies of learning environments, including the present study, have focused on these distinctions to develop a better understanding of population characteristics and behaviour. For example, Castillo (2007), using modified versions of the What Is Happening In this Class? (WIHIC) questionnaire and an attitude questionnaire based partly on the Test Of Mathematics-Related Attitudes (TOMRA), investigated the impact of ethnicity on attitudes and classroom environment perceptions. She found small ethnic differences on the 10 environment and attitude scales, with a statistically significant difference only for the Equity scale. However, for each environment and attitude scale, Anglo or white students' scores consistently were a little higher than Hispanic students' scores. Meanwhile, Moss (2003), who was also cited in an earlier section, found no ethnic (black versus non-black) differences in her classroom environment investigation.

Levy, den Brok, Wubbels and Brekelmans (2003) reported that African-American students thought that their teachers demonstrated greater leadership and were more helpful and friendly, though they also detected more uncertain behaviours than other students. The researchers also found that Asian-American students, in comparison with their peers, felt that their teachers provided them with significantly less responsibility and freedom and were stricter. Levy et al. (2003) noted that both findings were surprising because earlier studies had shown no differences between African-American students and their peers and in the case of Asian Americans contradicted earlier findings that Asians perceive less dominance and more submissive behaviour (den Brok et al., 2002; Levy et al., 1997).

Ethnicity is clearly a worthwhile construct to study but, as previous research has shown, no definitive conclusion about the perceptions of the members of any one group in any setting can be drawn. Different groups exhibit different characteristics in different settings.

2.8 Summary of the Chapter

In this chapter, I have attempted to synthesize literature relevant to my study and make conclusions that justify and guide my research. Key points about constructivism and the field of learning environments – issues that are central to this study – were highlighted and discussed in detail in a number of sections and subsections.

Constructivism and objectivism, two conflicting schools of thoughts about the way students learn and issues that are at the heart of this study, were introduced and discussed in Section 2.1. Researchers, such as Duit and Treagust (1995) and Taylor (1998), have pointed out that constructivists perceive learners as co-constructors of knowledge and are very much affected by environmental influences. Arguments by others like Duffy and Jonassen (1992), who explain why objectivists reject this view and instead embrace the idea that experience plays very little role in the learning process, were also examined.

Developments in the field of learning environments were reviewed in Section 2.3, including the pioneering contributions of researchers, such as Lewin (1936) and Murray (1938), who have been credited with conceptualizing the theories that inform the field. I also reviewed the works of Walberg, who developed the Learning Environment Inventory (LEI) for research on Harvard Project Physics (Walberg & Anderson, 1968) and Moos (1974b), who created the Classroom Environment Scale (CES).

Section 2.4 provided extensive coverage of the emergence and use of the most widely-recognized classroom climate assessment instruments: Learning Environment Inventory (LEI), Classroom Environment Scale (CES), Individualised Classroom Environment Questionnaire (ICEQ), My Class Inventory (MCI), College and University Classroom Environment Inventory (CUCEI), Questionnaire on Teacher Interaction (QTI), Science Laboratory Environment Inventory (SLEI), Constructivist Learning Environment Survey (CLES), and What Is Happening In this Class? (WIHIC).

My first research question involved the validation of the Constructivist Learning Environment Survey (CLES) and the Test of Science-Related Attitudes (TOSRA) for use with post-secondary students. Therefore, a detailed description of the development, structure and past use of these two questionnaires, as well as information about their validity and reliability in prior studies, were given. The CLES was discussed in Section 2.5 and TOSRA in Section 2.6.

Taylor, Fraser and White (1994) developed the original version of the CLES to monitor constructivist teaching approaches. It was modified by Taylor, Fisher and Fraser (1997) and is now shorter and more succinct. The CLES has been used throughout the world, including Australia and Taiwan (Aldridge, Fraser, Taylor & Chen, 2000), the United States (Spinner & Fraser, 2005; Peiro & Fraser, 2008), Korea (Kim, Fisher & Fraser, 1999) and South Africa (Aldridge, Fraser & Sebela, 2004). Time after time, it has proven to be valid and reliable in these diverse educational settings.

Section 2.6 reviewed literature on student attitudes and provided a detailed description of TOSRA, an instrument that has been developed to measure attitudes. Developed by Fraser (1978), TOSRA measures seven distinct science-related attitudes among second school students. It has been used in numerous countries, such as Australia (Rickards, den Brok & Fisher, 2005), Korea (Lee, Fraser & Fisher, 2003), and the USA (den Brok, Fisher, Rickards & Bull, 2006). Researchers have used and often modified one or more of the TOSRA scales as their needs dictated. Consistently, the instrument has been found to have good validity and reliability

when used with learners at all education levels and population groups. Findings of several past studies using TOSRA were also reviewed in this section.

Section 2.7 focused on determinants of classroom environment and past research on sex, age and ethnic differences in perceptions among students. The factors that Fraser (1994) identified as influences of the psychosocial learning environment were also discussed. In order to address the relevant research questions about whether sex, age and ethnicity are associated with differences in adult students' perceptions of their learning environment, I reviewed past studies that used learning environment instruments, particularly the CLES, to investigate students' perceptions of the learning environment.

Section 2.8 summarises and concludes the chapter. The next chapter provides information about the design of the study, the sample, the instruments used to gather the data and the methods used to analyse the data.

Chapter 3

METHODOLOGY

3.1   Introduction

The purpose of this chapter is to describe all the steps and procedures that I employed in conducting the study. The three research questions are recapitulated in Section 3.2, while background information and details about the selection of the sample are given in Section 3.3. Information about the participants is covered in Section 3.4. Details regarding the choice and selection of the two data-gathering instruments – the Constructivist Learning Environment Survey (CLES) and Test of Science-Related Attitudes (TOSRA) – are outlined in Section 3.5. Data collection is discussed in Section 3.6 and data analysis is presented in Section 3.7. A summary of the information in the chapter is given in Section 3.8.

3.2   Specific Research Questions

To confirm the validity and reliability of the CLES and TOSRA scales, the first of the three principal questions for this study was:

Research Question #1

Are the following questionnaires valid and reliable when used with adult learners in an urban two-year college:

> *a.   Constructivist Learning Environment Survey (CLES)*

> b. *a modified version of the Enjoyment of Science Lessons scale from Test of Science-Related Attitudes (TOSRA)?*

To explore whether the demographic factors of sex, age and ethnicity play a role in the way in which students perceive and enjoy the learning environment, the second research question was:

Research Question #2

Are there differences in learning environment perceptions and student enjoyment according to student:

> a. *sex*
>
> b. *age*
>
> c. *ethnicity?*

Finally, to determine whether there were associations between the learning environment and student satisfaction, the third question was:

Research Question #3

Are there associations between the classroom learning environment and the student outcome of satisfaction?

3.3 Background to and Selection of the Sample

The study was conducted in January 2009 at the North Campus of Miami Dade College. With more than 170,000 students in attendance, Miami Dade College is one

of the largest institutions of higher education in the USA. It is a publicly-supported commuter college with eight campuses and several outreach centres spread out over 60 miles across Miami-Dade County in southern Florida. Almost 9,500 students receiving Associate in Arts, Associate in Science, and Bachelor of Science degrees comprised its 2010 graduating class. Students come from 179 countries and speak 85 different languages. More than half are first-generation college students. Seventy-two percent work part-time while attending college and 20% work full-time. The details that are provided in the following paragraphs explain how the typical academic year is constituted and present a snapshot of the demographic make-up of the Fall 2008 cohort of students at the campus where this study was conducted.

The academic year at Miami Dade College begins in late August. It is the beginning of the fall semester. For instance, Fall 2008 (or 2008–1) was the beginning of the 2008–2009 academic year. Classes began on August 27, 2008, and the semester ended on December 19, 2008. The next semester was Spring 2008 (or 2008–2), which lasted from January 6 to May 1, 2009. The year ended with Summer 2008 (or 2008–3, the first 6 weeks, and 2008–4, the second 6 weeks). The calendar dates were from May 11 to July 31, 2009.

The most recent statistical information available from Miami Dade College Office of Institutional Research is for Fall 2008. Figures 3.1 to 3.3 show sex, age and ethnic distributions among the students at Miami Dade College North Campus during Fall 2008. My study was conducted at this campus.
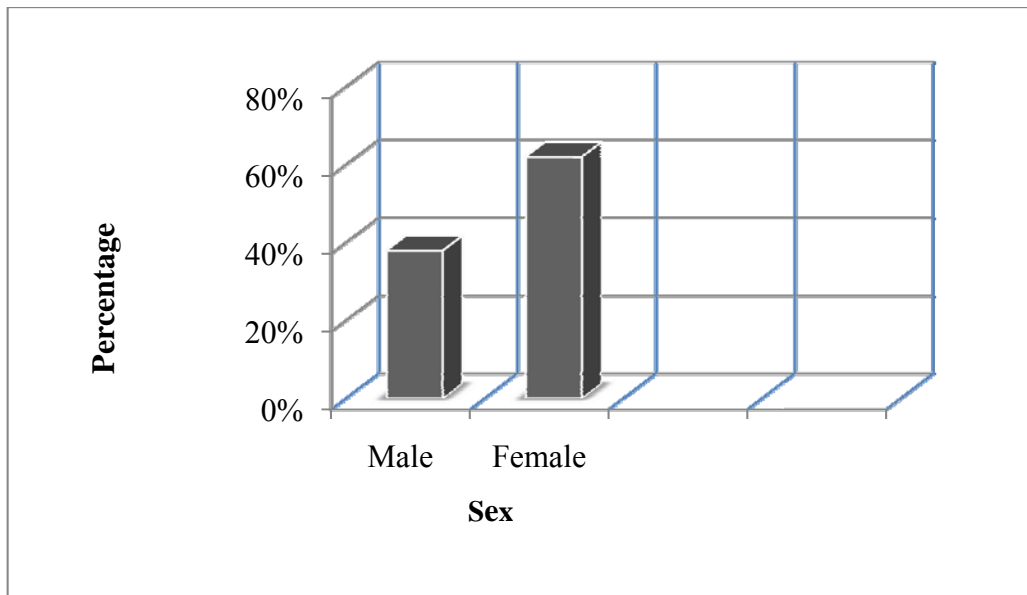
Figure 3.1.   Sex distribution of students at Miami Dade College North Campus in Fall 2008.

As indicated in Figure 3.1, women outnumber men almost 2:1 at the North Campus. Of the 16,272 students in attendance during Fall 2008, 10,088 or 62% were females and 38% or 6,183 students were men.
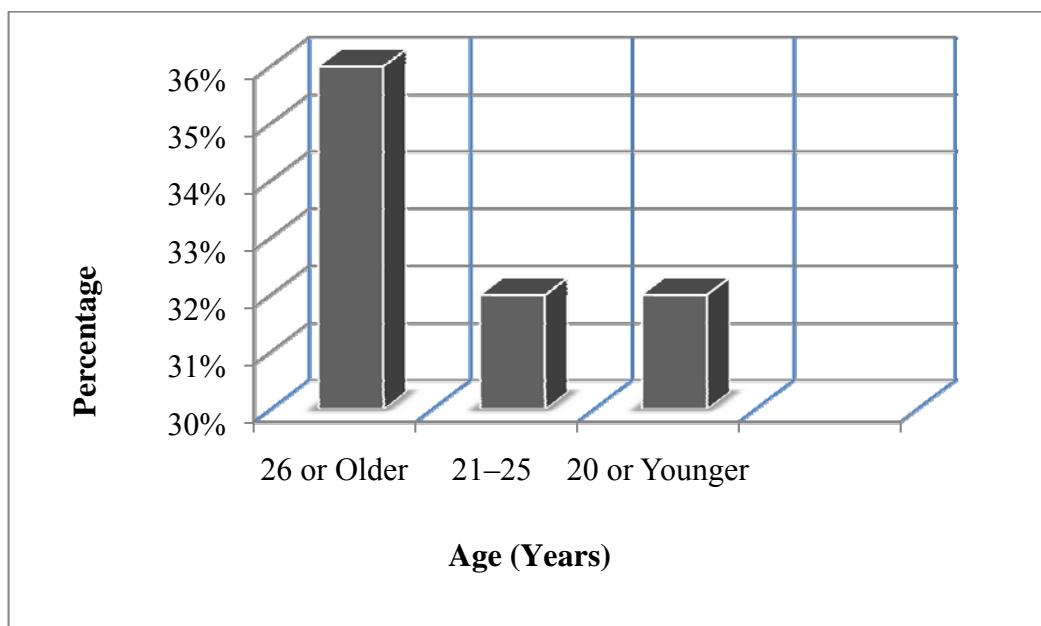
Figure 3.2.   Age distribution of students at Miami Dade College North Campus in Fall 2008.

According to the U.S. Department of State (2008): "The 'typical' college student of yesteryear – a secondary school graduate who entered an institution of higher education at the age of 17 or 18, studied full-time while living on campus and then graduated with a degree four years later – no longer is the norm on many U.S. campuses." Figure 3.2 shows that, in Fall 2008 at the campus where this study was conducted, most students were 26 years or older, confirming the U. S. State Department's assertion about age. In fact, of the 16,272 students in attendance, 36% or 5,859 fell into this category. The percentages were equal for the other two categories for which data were available. Each represented 32% or 5,207 students.
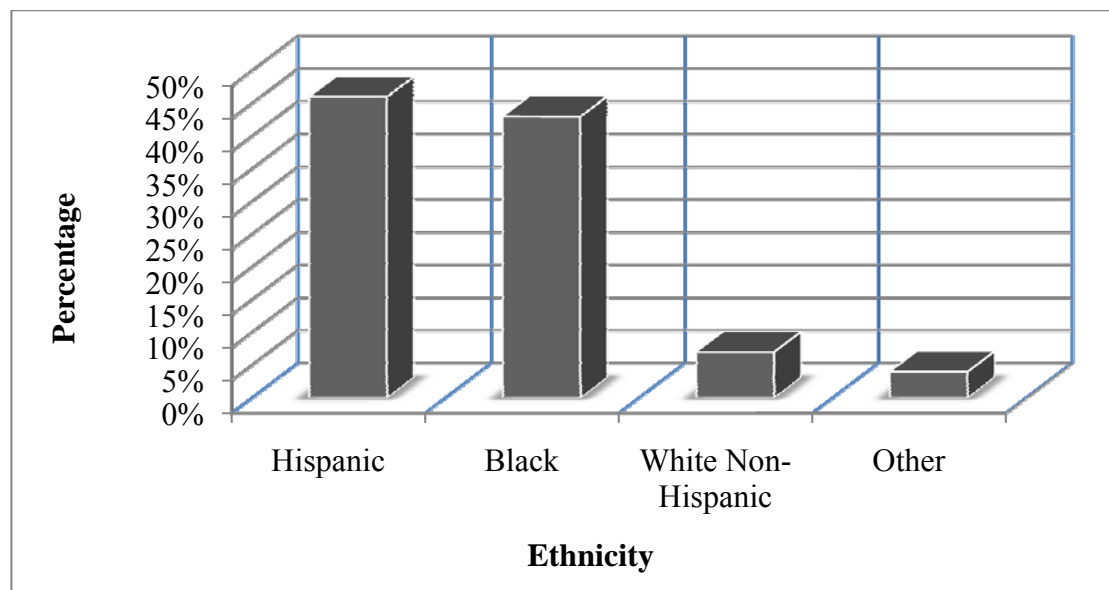
Figure 3.3.   Ethnic distribution of students at Miami Dade College North Campus in Fall 2008.

In Fall 2008, there were 7,517 Hispanics, 6,943 blacks and 1,138 whites in the student body. Figure 3.1 shows the percentages. A year earlier, in Fall 2007, the figures were 7,232 Hispanics, 6,877 blacks, and 1,048 whites. Between Fall 2007 and Fall 2008, enrolments increased for all ethnic groups: Hispanics by 285 or 4%, blacks by 66 or 1%, and whites by 90 or 9%. Enrolment data for Spring 2009, the

term in which the survey was conducted, were not available. However, based on the change between Fall 2007 and Fall 2008, it could be assumed that the ratio between each ethnic group did not change appreciably.

3.4   Participants

The sample of students who responded to the survey consisted of 544 students in 29 classes taught by 11 different staff members. The classes were ENC0002 College Preparatory Writing 1 (1 section), ENC0020 College Preparatory Writing 2 (5 sections), ENC0021 College Preparatory Writing 3 (9 sections), ENC1101 English Composition 1 (2 sections), ENC1102 English Composition 2 (1 section), REA0002 College Preparatory Reading 2 (2 sections), REA0003 College Preparatory Reading 3 (7 sections) and Paired REA0002/0003 College Preparatory 2 and 3 (2 sections).

The raw data are captured in Table 3.1. As the table shows, the total sample consisted of 226 males and 318 females. The categories for the 'age range' on the questionnaire (see Appendix B) were as follows: (1) 18–24 years = 435; (2) 25–34 years = 65; (3) 35–44 years = 32; (4) 45–54 years = 8; (5) 55–64 years = 1; and (6) 65+ years = 3. For ethnicities, they were: (1) American Indian/Alaskan Native = 4; (2) Asian = 9; (3) African American = 280; (4) Native Hawaiian/Pacific Islander = 3; (5) White = 59; and (6) Others = 189.

The responses to the surveys yielded results that were hard to compare. For example, of the 544 students in the sample, 435 students selected the 18–24 years

age range and the rest – 109 students – selected the other 5 age groups. Only 1
student selected the 55–64 years age range while only 3 selected the 65+ age range.

**Table 3.1   Demographic Data for Sample Before Combining Age Ranges
with Few Responses**

Age		Sex		Ethnicity	
Range (Years)	Frequency	Category	Frequency	Category	Frequency
18–24	435	Male	226	American Indian/Alaskan Native	4
25–34	65			Asian	9
35–44	32			African American	280
45–54	8	Female	318	Native Hawaiian/Pacific Islander	3
55–64	1			White	59
65+	3			Others	189

Sample consisted of 544 students in 29 classes.

Comparing the number of students in one age range with the number of students in
each of the other age ranges as found in the original survey design (see Appendix A)
would have been difficult and perhaps meaningless. Therefore, though it was not
ideal, it was decided to compare 435 students younger than 25 years of age with 109
students who were older than 25.

The responses for ethnicity showed a similar disparity among the various categories
from which the students selected. Because it would have been unwise to compare all
the age ranges, I decided to combine groups with few respondents. Two groups

seemed feasible: the 280 students who self-identified as African Americans, and a combined group of 264 students who selected all other ethnicities.

The final breakdown of the sample that was used to analyse sex, age and ethnic differences is shown in Table 3.2. There was no problem with the data for the sex categories. The 226 male students were compared with the 318 female students in the sample.

Table 3.2   Demographic Data for Sample After Combining Age Ranges with Few Responses

Age		Sex		Ethnicity	
Range (Years)	Frequency	Category	Frequency	Category	Frequency
Younger than 25	435	Male	226	African American	280
25 and older	109	Female	318	Other Ethnicities (American Indian/Alaskan Native, Asian Native Hawaiian/Pacific Islander White)	264

Sample consisted of 544 students in 29 classes.

3.5   Instrument Selection

The Constructivist Learning Environment Survey (CLES) is the learning environment questionnaire that was used in this study to investigate differences in student perceptions. A modified scale of the Test of Science-Related Attitudes (TOSRA) was used to assess attitudes and to permit investigation of associations

between the learning environment and student satisfaction. A sample item and a

brief description of each scale of the CLES and the revised Enjoyment Scale of the

TOSRA are provided in Table 3.3.

Table 3.3   Scale Description and Sample Item for Each CLES and TOSRA Scale

Instrument/Scale Name	Number of Items	Scale Description	Sample Item
CLES			
Personal Relevance	6	Link between classroom and real world experiences	I learn about the world outside of school.
Uncertainty	6	Opportunities for students to experience knowledge	I learn that this subject cannot provide perfect answers to problems.
Critical Voice	6	Receptiveness to student insight, opinions, and questions	It's OK for me to ask the teacher 'Why do I have to learn this?'
Shared Control	6	Student involvement in planning, designing, and assessing classroom activities	I help the teacher decide which activities are best for me.
Student Negotiation	6	Opportunities for students to discuss new knowledge among themselves	I get the chance to talk to other students.
TOSRA			
Enjoyment of Lessons	10	Extent to which students enjoy and look forward to the class.	Lessons in this subject are fun.

As noted earlier, the Constructivist Learning Environment Survey (CLES) was

developed by Taylor, Fraser, and Fisher (1997) to measure psychosocial dimensions

of classrooms, whereas the Test of Science-Related Attitudes (TOSRA) was

developed by Fraser (1981) to measure attitudes related to science. According to

Watters and Ginns (1995): "The differences in these instruments relate to specific versus global perceptions of attitudes. The CLES reflects on the immediate intervention and learning experience. The TOSRA considers established beliefs and attitudes" (p. 1).

3.5.1 Constructivist Learning Environment Survey (CLES)

The Constructivist Learning Environment Survey (CLES) was selected for use in this study, first, because of the student-centred philosophy of Miami Dade College and, second, because of its proven reliability and validity and its cross-cultural and multi-level academic adaptability (Section 1.4.1). The questionnaire has been used successfully with students at all pedagogical levels in a number of countries around the world. Also, its five scales (Personal Relevance, Uncertainty, Shared Control, Critical Voice and Student Negotiation) measure Moos's (1974) three general dimensions of all human environments (relationship, personal development and systems maintenance and change). There are two CLES scales each for the relationship and personal development dimensions and one for system maintenance. In other questionnaires, such as the What Is Happening In this Class? (WIHIC) and the Questionnaire on Teacher Interaction (QTI), the scales are less evenly distributed among these three dimensions (see Table 2.1). Third, with only six items in each scale, the CLES seemed highly economical for use in the college setting, where class meeting times are short and teachers and students loathe taking on time-consuming tasks which are not directly related to their courses.

In the previous chapter, an extensive description of the CLES was provided in Chapter 2, Section 2.5. The scales of the CLES – Personal Relevance, Uncertainty of Science, Critical Voice, Shared Control and Student Negotiation – help researchers to evaluate the impact of constructivist teaching approaches on student outcomes (Fraser, 1991, p. 21). The instrument has a five-point frequency response scale: Almost Always (5 points), Often (4 points), Sometimes (3 points), Seldom (2 points), and Almost Never (1 point). As reported by Taylor, Fraser, and Fisher (1997), Cronbach's alpha coefficient for the scales of the current version of the CLES ranged from 0.61 to 0.89 – values that exceed the recommended level of 0.60 (Nunally, 1967).

Comparable validity results have been found in numerous studies with the CLES conducted in elementary, middle, and high schools in various countries, including Australia and Taiwan (Aldridge, Fraser, Taylor & Chen, 2000), Korea (Kim, Fisher & Fraser, 1999), the United States (Nix, Fraser & Ledbetter, 2005) and South Africa (Sebela, Aldridge, & Fraser, 2004). However, few studies using the CLES with adult learners in an urban college setting have been undertaken to determine whether the usefulness of the instrument is replicated at this level. Thus, one of the major reasons for selecting the CLES for use in this study was its proven reliability and validity in a variety of classroom environments around the world (see Section 2.2).

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

The detailed information about TOSRA previously presented in Chapter 2, Section 2.6 established that it was designed to measure science students' attitudes at the

secondary level (Fraser, 1981). The seven scales are called Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. The instrument uses a Likert-type rating scale with respondents choosing one of five response alternatives that best aligns with their view. The options are Strongly Agree (SA), Agree (A), Not Sure (N), Disagree (D) and Strongly Disagree (SD).

According to Fraser (1981), "the 70 items in TOSRA are allocated to the seven different scales and each item is positive (+) or negative (-) with respect to scoring. For positive items (+), responses for SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (-), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively" (p. 9). The Cronbach's alpha coefficient for the original TOSRA scales ranged from 0.64 to 0.93, an indication that each scale had good internal consistency reliability (Cheung, 2007; Fraser, Aldridge & Adolphe, 2010; Moher, Hussain, Barron & Thompson, 2006; Robinson, 2003).

Fraser (1981) found that three scales of the TOSRA – Leisure Interest in Science, Career Interest in Science, and Enjoyment of Science Lessons – measure overlapping dimensions. This development has resulted in the selection of just one of these three scales to measure attitude (Aldridge, Fraser, Taylor & Chen, 2000; Fraser & Lee, 2009). As with the CLES, few studies using the TOSRA or one its variations have been undertaken with adult learners in an urban college setting.

Table 3.4   Wording of Items in Original and Modified Versions of TOSRA's Enjoyment of Lessons Scale

Original Version		Modified Version	
Polarity	Item	Polarity	Item
+	Science lessons are fun.	+	Lessons in this subject are fun.
-	I dislike science lessons.	+	I like lessons in this subject.
+	Schools should have more science lessons each week.	+	There should be more lessons in this subject this week.
-	Science lessons bore me.	+	Lessons in this subject do not bore me.
+	Science is one of the most interesting school subjects.	+	This is one of the most interesting subjects in college.
-	Science lessons are a waste of time.	+	Lessons in this subject are not a waste of time.
+	I really enjoy going to science lessons.	+	I really enjoy going to lessons in this subject.
-	The material covered in science lessons is uninteresting.	+	The material covered in lessons in this subject is interesting.
+	I look forward to science lessons.	+	I look forward to lessons in this subject.
-	I would enjoy school more if there were no science lessons.	+	I would enjoy college more if there were more lessons in this subject.

Because considerable past research (e.g., Fraser, 1981; Fraser, Aldridge & Adolphe, 2010; Fraser & Fisher, 1982; Lightburn & Fraser, 2007; McRobbie & Fraser, 1993; Wong & Fraser, 1996) has confirmed the validity and reliability of TOSRA, and because one of my research questions focused on associations between the learning environment and student satisfaction, I selected and modified TOSRA's Enjoyment of Science Lessons scale to assess students' attitudes toward their learning experiences in the classrooms in which they were surveyed.

To more accurately reflect the scope and purpose of this study, the modified TOSRA scale was renamed the Enjoyment of Lessons scale. Each of the 10 items on the scale was reworded. In particular, all 5 negatively-worded items were rewritten as positively-worded items in order to eliminate or minimize the probability of misinterpretation. Cheung (2009) states: "A combination of positively and negatively worded items was often used by researchers to construct Likert-type scales to reduce the effects of acquiescence and other response biases. However, the 'conventional wisdom' these days is not to mix positive and negative items for a dimension" (p. 79).

Cheung (2009) adds that researchers (e.g., Miller & Cleary, 1993; Pilotte & Gable, 1990; Schmitt & Stults, 1985) have found that negatively-worded items, written as reversals of positively-worded items, can load on separate factors, forming a measurement artefact. Additionally, the renaming of the scale made it applicable to all subjects and not just a specific one. Table 3.4 juxtaposes the items from the original Enjoyment of Science Lessons scale of the TOSRA and the modified Enjoyment of Lessons scales used in my study.

3.6   Data Collection

After requesting and receiving permission from the Institutional Research office at Miami Dade College to conduct research at the North Campus (see Appendix A), I canvassed several of my colleagues in the College Preparatory Department and one from the English Department to determine if they would be willing to help me with my study. Ten agreed. These staff members offered to administer the surveys on my

behalf in classes that they chose. Some teachers taught reading courses and some taught writing courses. I met individually with the teachers and discussed the procedures for administering the survey.

An eight-page booklet (see Appendix B) containing the participant information sheet, consent form, survey instruments, and demographic information chart was compiled, packaged and distributed to test administrators. The instructions for the teacher in each class were to ask every student over 18 years of age, who by law can make decisions about his or her academic records, to volunteer to complete the survey for the study and to explain that the exercise was not a class assignment that would be graded. Each student who volunteered to participate was then given a booklet containing information for participants about the survey and directions to complete the questionnaires, which were printed in the same booklet. On average, each student took about 30 minutes to read the directions and complete the survey.

All surveys were completed and returned to me within two weeks. Thirty questionnaire responses with incomplete data were identified and discarded. Among them were 5 from students who failed to select an age category, 7 from some who did not choose an ethnic group, and 6 from others who did not indicate their sex. The remaining 12 were from students who started the survey but skipped several CLES or TOSRA items. Data from the completed questionnaires were then entered into an Excel spreadsheet. Further analysis was undertaken using Statistical Package for Social Sciences (SPSS) software.

3.7   Data Analysis

The purpose of this section is to describe the statistical analysis procedures used to answer my research questions. The aim of the first question was to determine the validity of the CLES and the revised TOSRA scale, the questionnaires used in the study. Validation procedures are discussed in Section 3.7.1. The second question focused on the impact of sex, age and ethnicity as determinants of classroom environment and attitudes. Section 3.7.2 outlines the statistical tests used to detect sex, age and ethnic differences. The final research question addressed the effects of the learning environment on student attitudes using simple correlation, multiple correlation and standardized regression coefficients as explained in Section 3.7.3.

3.7.1   *Instrument Validation*

To imbue confidence in an instrument's ability to deliver the expected measurements, it is vital that researchers assess its validity and reliability prior to its use. To answer Research Question 1 concerning whether the Constructivist Learning Environment Survey (CLES) and a modified version of the Enjoyment of Science Lessons scale of Test of Science-Related Attitudes (TOSRA) are valid and reliable when used with adult learners in an urban college setting, several analyses were carried out. First, principal components factor analysis followed by varimax rotation with data from 544 students was used to confirm the *a priori* structure of the 30-item instrument with 6 items per scale. Items from the CLES that had factor loadings that were less than 0.40 on their own scale or greater than 0.40 on other scales were removed in order to improve the internal consistency reliability and discriminant

validity. Section 4.3.1 provides more detailed information about the factor structure of the CLES.

Second, Cronbach's alpha coefficient was used as a measure of the internal consistency reliability of each of the scales of the CLES and the Enjoyment scale of the TOSRA. Internal consistency reliability is the method of establishing whether items on a questionnaire elicit similar responses under similar conditions every time it is administered. Analyses were undertaken for each CLES scale and for the Enjoyment scale of the TOSRA and were performed separately for the individual student level and the class level. The findings are reported in Section 4.3.2.

Third, the discriminant validity, a concept introduced by Campbell and Fiske (1959) to evaluate test validity, refers to a questionnaire's ability to distinguish among the constructs that it is supposed to distinguish. In this study, two units of analysis were used: the student and the class mean. Analyses were undertaken for each CLES scale separately for the individual student level and the class level. The expectation was that related traits would not correlate highly. It was found that the CLES scales have sound discriminant validity in that they are able to assess mutually-exclusive dimensions of classroom environment. Section 4.3.3 reports the discriminant validity values that were obtained.

Finally, in order to give further support to the validity of the CLES, an analysis of variance (ANOVA) was used to determine whether each scale could detect differences in perceptions between students in the 29 different classrooms. The eta^2 values, which are the ratios of 'between' to 'total' sums of squares and represent the

proportion of variance explained by class membership, were computed in order to determine whether each scale of the CLES differentiated significantly between the perceptions of students in different classes. Table 4.2 and Section 4.3.4 provide information about the range of scores.

3.7.2 Sex, Age and Ethnic Differences in Students' Classroom Environment Perceptions and Attitudes

Research Question 2 concerned differences in students' perceptions of their learning environment and the enjoyment of their classroom experiences according to their sex, age and ethnicity. As discussed earlier in Section 3.4, the data first had to be synthesized to ensure that the categories were meaningful statistically. Then, to answer this research question, a number of statistical analyses were conducted.

First, a three-way MANOVA was performed to examine whether age, sex and ethnic differences were evident in the scores obtained from the set of CLES scales and the Enjoyment of Lessons scale of TOSRA. Wilks' lambda criterion (Λ), a test statistic used in multivariate analysis of variance (MANOVA), was used to determine whether there were between-group differences for any combination of the six dependent variables. Additionally, the univariate analysis of variance (ANOVA) was interpreted for each CLES scale and for the Enjoyment of Lessons scale when Wilks' lambda turned out to be significant (Field, 2000).

Also, effect sizes were used to indicate the magnitudes of those differences. The effect size is the difference between the two means divided by the pooled standard deviation (Coe, 2002). Section 4.4 and Tables 4.3, 4.4 and 4.5 in Chapter 4 report

differences (including effect sizes) in classroom environment perceptions and enjoyment among the different groups.

3.7.3   *Environment-Outcome Associations*

Finally, to answer Research Question 3 concerning whether there were associations between the classroom learning environment and student enjoyment, simple correlation (*r*) and multiple regression analyses were used. The two units of analysis were the student and the class mean. The simple correlation (*r*) describes the bivariate association between student enjoyment and each classroom environment scale. The multiple correlation (*R*) describes the multivariate relationship between student enjoyment and the set of CLES scales. The regression coefficient (β) provides information about the association between student enjoyment and a particular environment scale when all of the other environment scales are mutually controlled. The associations between student enjoyment and classroom environment are reported in Section 4.5 in the next chapter.

3.8   Summary of the Chapter

This chapter discussed the sample, instruments, and procedures used in this study, which was designed to validate two questionnaires, to investigate sex, age and ethnic differences in perceptions of the learning environment and student attitudes, and to determine the strength and statistical significance of the environment-attitude associations.

The sample consisted of 544 students in 29 classes taught by 11 different staff members from one of the campuses of Miami Dade College in Florida, USA. The students were categorized according to sex, age and ethnicity. The small size of the sample is a limitation as it restricts the interpretation of the results and their generalizability.

To assess students' perceptions of the learning environment, the 30-item Constructivist Learning Environment Survey (CLES) was administered. To assess attitudes to the learning environment, a 10-item modified version of the Enjoyment of Science scale of the Test of Science-Related Attitudes (TOSRA) was used. The data collected were used to explore the reliability and validity of the CLES and TOSRA scales, to determine sex, age and ethnic differences in students' perceptions of the learning environment and attitudes and to investigate associations between the environment and the student outcome of enjoyment.

Factor analysis was used to check the structure of the CLES. Cronbach's alpha coefficient was used to measure the internal consistency of the CLES scales and the Enjoyment of Lessons scale of the TOSRA. Discriminant analysis was measured using the mean correlation of a scale with the other scales of the questionnaires. Analysis of variance (ANOVA) was used to check the questionnaires' ability to distinguish between perceptions of students in the 29 different classrooms, with the eta^2 statistic providing an estimate of the strength of association between class membership and CLES scores.

A three-way multivariate analysis of variance (MANOVA) was used to examine sex, age and ethnic differences. The set of six CLES scales and the Enjoyment scale were used as the dependent variables. Effect sizes, which refer to the size of the relationship between two variables, were computed to determine the magnitude of the differences between sexes, ages and ethnicities.

Finally, to investigate environment-outcome associations, simple correlation and multiple regression analyses were conducted using the individual student and the class mean as the two units of analysis. The Enjoyment scale served as the dependent variable while the set of five CLES scales constituted the set of independent variables. To identify which classroom environment scales contributed most to the variance in student enjoyment, the standardised regression weights were examined.

Chapter 4 presents my analyses and findings. Tables that summarize the data are included, along with detailed explanations of the findings for each objective of the study.

Chapter 4

ANALYSES AND RESULTS

4.1   Introduction

The purpose of this chapter is to report the findings based on analyses of the quantitative data that were gathered in this research study. The discussion is organized and presented in sections and subsections that are structured around the study's three main objectives: (1) to validate the questionnaires that were used to collect the data, (2) to ascertain whether differences in learning environment perceptions could be attributed to students' demographic backgrounds and (3) to determine whether there were associations between student enjoyment and the classroom learning environment.

Section 4.2 summarizes the research methods. Section 4.3 reports the validation of the Constructivist Learning Environment Survey (CLES) and a modified version of the Enjoyment scale from the Test of Science-related Attitudes (TOSRA). Section 4.4 reports sex, age and ethnic differences in learning environment perceptions and enjoyment. Section 4.5 reports the findings regarding associations between scores on the Enjoyment scale and students' perceptions of classroom environment as assessed by the five CLES scales. Section 4.7 summarizes and concludes the chapter.

4.2   **Summary of Research Methods**

This study validated learning environment questionnaires, investigated sex, age and ethnicity as determinants of classroom environment and explored the effects of the learning environment on student attitudes at an urban two-year or junior college in Florida, USA. The specific research questions were:

Research Question #1

Are the following questionnaires valid and reliable when used with adult learners in an urban two-year college:

   a. *Constructivist Learning Environment Survey (CLES)*

   b. *a modified version of the Enjoyment of Science Lessons scale from Test from Science-Related Attitudes (TOSRA)?*

Research Question #2

Are there differences in learning environment perceptions and student enjoyment according to student:

   a. *sex*

   b. *age*

   c. *ethnicity?*

Research Question #3

Are there associations between the classroom learning environment and the student outcome of satisfaction?

The sample consisted of 544 students in 29 classes randomly-chosen from three subject areas at an urban two-year college campus in Florida. Section 3.4 in the previous chapter provides a detailed description of the sample. The CLES was used to assess the way in which students perceived their classroom environment, whereas a modified version of the Enjoyment of Science Lessons scale from the TOSRA was used to assess students' attitudes toward the subject taught in the classes surveyed.

The first aim of the study was to validate the CLES and the revised TOSRA scale when used with adult learners. Factor analysis was used to check the structure of the CLES. Cronbach's alpha coefficient was calculated as an index of scale internal consistency and the mean correlation of a scale with the other scales was used as a convenient index of discriminant validity. The individual and the class mean were used as the units of analysis. An analysis of variance (ANOVA) was used to determine whether each scale could differentiate between the perceptions of students in different classrooms.

The second aim of the study was to investigate sex, age and ethnicity as determinants of classroom environment. Univariate analysis of variance (ANOVA) and a three-way multivariate analysis of variance (MANOVA) were used to detect statistically significant sex, age and ethnic differences. Sex, age and ethnicity made up the set of independent variables and the five CLES scales and the Enjoyment scale of the TOSRA were the dependent variables. Additionally, the effect size or the magnitude for each difference was calculated.

The third aim was to explore the effects of the learning environment on student attitudes at an urban two-year or junior college. Simple correlation (*r*), multiple correlation (*R*) and standardized regression coefficients (β) were used to determine which of the independent variables were related to the dependent variable. The individual student and the class means were used as the two units of analysis.

4.3   Validity and Reliability of Questionnaires

Fraser (1986b) notes that an instrument's validity and reliability serve to enhance confidence among users and potential users. He identifies factor structure, internal consistency and discriminant validity as three of the most important validation indexes. The alpha coefficient (Cronbach, 1951) is the most common index used with classroom environment instruments and the intercorrelation between scales is often used to indicate discriminant validity. Another desirable characteristic of any classroom environment instrument scale is that it is capable of differentiating between the perceptions of students in different classrooms. In other words, students within the same classroom should perceive it relatively similarly while mean within-class perceptions should vary from classroom to classroom. Thus, in order to answer Research Question #1, the succeeding subsections report the factor structure of the CLES followed by data on the internal consistency reliability, discriminant validity and the ability to differentiate between classrooms for both the CLES and the revised Enjoyment scale of the TOSRA.

4.3.1 Factor Structure of the CLES

Data collected from the survey of 544 students in 29 classes were analysed to check the CLES's validity when used with two-year college students. When the structure of the CLES was checked using factor analysis to identify items whose removal would improve the instrument's internal consistency reliability and factorial validity, the factor loadings reported in Table 4.1 were found.

Principal axis factoring followed by varimax rotation with Kaiser normalization confirmed the *a priori* structure of the CLES, which is comprised of 30 items. Only items with factor loadings of at least 0.40 on their own scale and less than 0.40 with each of the other scales were retained. After Items 3, 6 and 7 had been omitted, all remaining items had a loading of at least 0.54 on their own scale (as well as a loading of less than 0.40 on all other scales).

The bottom of Table 4.1 shows that the proportion of variance accounted for ranged from 5.63% to 28.28% for different CLES scales. The total proportion of variance was 63.88%. Eigenvalues for different scales ranged from 1.52 to 7.64. Overall, the findings reported in Table 4.1 provide strong support for the factor structure of the CLES. Similar results were reported for the CLES in various countries, including Korea (Kim, Fisher & Fraser, 1999), the United States (Nix, Fraser & Ledbetter, 2005) and Australia and Taiwan (Aldridge, Fraser, Taylor & Chen, 2000).

Table 4.1   **Factor Analysis Results for the CLES**

Item	Factor Loadings				
	Personal Relevance	Uncertainty	Critical Voice	Shared Control	Student Negotiation
CLES1					0.58
CLES2					0.55
CLES4					0.69
CLES5					0.78
CLES8				0.54	
CLES9				0.69	
CLES10				0.55	
CLES11				0.56	
CLES12				0.57	
CLES13			0.57		
CLES14			0.67		
CLES15			0.68		
CLES16			0.69		
CLES17			0.69		
CLES18			0.71		
CLES19		0.69			
CLES20		0.75			
CLES21		0.81			
CLES22		0.85			
CLES23		0.85			
CLES24		0.68			
CLES25	0.59				
CLES26	0.80				
CLES27	0.85				
CLES28	0.85				
CLES29	0.85				
CLES30	0.85				
% Variance	28.28	11.80	9.50	8.67	5.63
Eigenvalue	7.64	3.19	2.57	2.34	1.52

Extraction method: Principal axis factoring. Rotation method: Varimax with Kaiser normalization
Sample consisted of 544 students in 29 classes.
Items 3, 6 and 7 were omitted
Loadings less than 0.40 have been omitted in the table.

4.3.2   *Internal Consistency Reliability of CLES and the Revised Scale of TOSRA*

Internal consistency indicates the degree to which different items on a survey instrument designed to measure the same characteristic are consistent (McMillan, 2008). The smaller the variability among the answers given by respondents, the greater the internal consistency reliability of the instrument is thought to be. Cronbach's alpha coefficient is one type of internal consistency reliability measure that indicates how closely related a set of items is as a group. The higher the alpha

is, the more reliable the instrument is. Nunnally (1978, p. 245) recommends that instruments used in basic research have a reliability of about 0.70 or higher.

Table 4.2   Internal Consistency Reliability (Cronbach's Alpha Coefficient) and Discriminant Validity (Mean Correlation with Other Scales) for Two Units of Analysis and Ability to Differentiate Between Classrooms (ANOVA Results) for CLES and TOSRA Scales

Scale	Unit of Analysis	No of Items	Alpha Reliability	Mean Correlation with Other Scales	ANOVA Eta^2
Personal Relevance	Student	4	0.78	0.29	0.09**
	Class		0.70	0.33	
Uncertainty	Student	5	0.76	0.31	0.07
	Class		0.85	0.41	
Critical Voice	Student	6	0.84	0.25	0.09**
	Class		0.82	0.23	
Shared Control	Student	6	0.91	0.28	0.16**
	Class		0.93	0.47	
Student Negotiation	Student	6	0.93	0.31	0.17**
	Class		0.94	0.36	
Enjoyment	Student	10	0.89		
	Class		0.93		

**p<0.01
The sample consisted of 544 students in 29 classes.
Eta^2 is the ratio of 'between' to 'total' sums of squares and represents the proportion of variance in scale scores accounted for by class membership.

Table 4.2 reports the internal consistency reliability (Cronbach's alpha coefficient) for each of the five scales of the CLES and the Enjoyment scale of the TOSRA. Analyses were performed separately for the individual student and the class mean as units of analysis. For different CLES scales, the alpha reliability ranged from 0.76 to 0.93 at the student level and from 0.70 to 0.94 at the class level. For the Enjoyment scale, the reliability was 0.89 for individuals and 0.93 for class means. As indicated earlier, the higher the alpha reliability score, the more reliable the generated scale is and 0.70 is considered to be an acceptable reliability coefficient. Thus, the high values for Cronbach's alpha for the CLES and the revised TOSRA

scale that were obtained from the sample indicate good internal consistency of the items in the scales.

4.3.3 *Discriminant Validity of the CLES*

The discriminant validity is the extent to which a measure discriminates from other measures. In other words, it establishes whether measures that should not be related are indeed not related. The mean correlation of a scale with the other scales of a questionnaire was used as a convenient measure of discriminant validity. Lower mean correlations reflect greater discriminant validity. Strong evidence for discriminant validity imbues confidence in research findings (Farrell, 2009). The discriminant validity or independence of CLES scales was checked using the mean correlation of a scale with the other scales as a convenient index and using two units of analysis (the student and the class mean). Table 4.2 shows that the discriminant validity of different CLES scales ranged from 0.25 to 0.31 with the student as the unit of analysis and from 0.23 to 0.47 for class means. Although these values of the discriminant validity suggest some overlap in raw scores on different CLES scales, the factor analysis attests to the independence of raw scores.

4.3.4 *Ability of the CLES Scales to Differentiate Between Classrooms*

To provide further evidence of the validity of the questionnaires, an analysis of variance (ANOVA) was used to investigate whether each CLES scale could differentiate between the perceptions of students in the 29 different classes. Class membership was the independent variable for each ANOVA. The statistically

significant results reported in Table 4.2 indicate that most CLES scales were able to detect disparities in perceptions between students in the 29 different classrooms.

The eta^2 statistic, which is an estimate of the strength of association between class membership and CLES scale scores, ranged from 0.07 to 0.17. These values that are reported in Table 4.2 provide a measure of the strength of the association between class membership and scores on a CLES scale. With the exception of the Uncertainty scale, each CLES scale differentiated significantly ($p<0.01$) between classrooms.

4.4 Sex, Age and Ethnic Differences in Classroom Environment Perceptions and Enjoyment

Research Question #2 concerned the existence of differences in learning environment perceptions and enjoyment according to student sex, age and ethnic differences. The sample consisted of 544 students in 29 classes. There were 226 males to compare with 318 females. With regard to age, 435 students who were less than 25 years of age were compared to 109 who were 25 years or older. On the questionnaire, students were asked to select from six age ranges the one that best described them. The resulting data set was as follows:

- 18–24 years = 435 students
- 25–34 years = 65 students
- 35–44 years = 32 students
- 45–54 years = 8 students
- 55–64 years = 1 student
- 65+ years = 3 students.

Because it did not appear that the frequencies that emerged for all the ranges would have been useful for statistical analysis, I decided to combine the age ranges into two categories – younger than 25 to compare with 25 and older – which seemed more logical and functional. As for ethnicity, 280 students who identified themselves as African Americans were compared to 264 who selected other ethnicities.

As it did with age ranges, the questionnaire had several categories associated with ethnic groupings. Students were asked to select the one that best identified them. The raw data that were collected highlight an inherent problem. There were two few respondents in some categories to permit meaningful statistical analyses:

- American Indian/Alaskan Native = 4 students

- Asian = 9 students

- African American = 280 students

- Native Hawaiian/Pacific Islander = 3 students

- White = 59 students

- Others = 189 students.

Given the problem with the original selections, the challenge then was to find a way to use the data meaningfully. Given the large number of students who identified themselves either as African American or as 'Other', and the relatively small number who chose the remaining options, it was decided simply to compare African Americans with students who did not identify themselves as such. Section 3.4 in the previous chapter provides a more detailed description of the sample.

Sex, age and ethnic differences were explored using a three-way MANOVA with the set of six CLES scales and Enjoyment as the dependent variables. Because Wilks' lambda criterion (Λ) suggested that there were no significant interactions between any of the three independent variables of sex, age and ethnicity, I interpreted the results separately for each of the sex, age and ethnicity main effects.

Furthermore, because the multivariate test using Wilks' lambda criterion (Λ) revealed statistically significant sex, age and ethnic differences for the set of dependent variables as a whole, the univariate ANOVA results were interpreted separately for each CLES and TOSRA scale. The ANOVA results for sex, age and ethnic differences are reported, respectively, in Tables 4.3, 4.4 and 4.5.

In addition to investigating the statistical significance of differences between sexes, ages and ethnicities, the magnitude or effect size (Thompson, 1998) for each difference was also estimated. The effect size was calculated by dividing the difference between two means by the pooled standard deviation to express a difference in standard deviation units. Effect sizes are also reported in Tables 4.3, 4.4 and 4.5.

4.4.1 Sex Differences

Table 4.3 shows that sex differences were nonsignificant for every CLES scale and that the corresponding effect sizes, which are indicators of the strength of association between the variables, were small. For each of the Personal Relevance, Uncertainty, Critical Voice and Student Negotiation scales of the CLES, the average

item mean is highly similar for males and females and was above 3.00, the midpoint

score, suggesting relatively positive classroom perceptions. The effect sizes, whose

magnitudes ranged from only 0.02 to 0.10 standard deviations, reinforce the

smallness of the sex difference in learning environment perceptions. However, the

average mean scores for Shared Control for both sexes, though slightly higher for

males than for females, were below the midpoint at 2.50 and 2.45, respectively,

suggesting perhaps unfavourable perceptions.

Table 4.3.   **Average Item Mean, Average Item Standard Deviation and Sex
Difference (Effect Size and MANOVA Results) for Each Classroom
Environment and Attitude Scale**

Scale	Average Item Mean		Average Item SD		Difference	
	Males	Females	Males	Females	Effect Size	*F*
Personal Relevance	3.32	3.27	0.87	0.85	0.06	0.02
Uncertainty	3.43	3.48	0.77	0.85	-0.06	0.06
Critical Voice	3.84	3.86	0.84	0.90	-0.02	0.03
Shared Control	2.50	2.45	1.07	1.10	0.05	2.14
Student Negotiation	3.43	3.53	0.98	1.08	-0.10	0.51
Enjoyment	3.33	3.91	0.68	0.63	-0.88	6.56**

**$p<0.01$
The total sample of 544 students consisted of 226 males and 318 females.

For the Enjoyment scale, sex differences were statistically significant and were

associated with a large effect size of 0.88 standard deviations. This suggests an

educationally important sex difference for this attitude scale. The interpretation was

that females expressed greater enjoyment in their classes than did males. This

pattern of results is consistent with research by Calabrese and Poe (1990), Sullivan,

Riccio and Reynolds (2008), Trusty and Dooley-Dickey (1993) and Hoang (2008),

who also reported higher levels of female satisfaction with school. There is strong

evidence that suggests that positive attitudes toward school are associated with more

supportive relationships with school personnel and higher academic outcomes (Sullivan, Riccio & Reynolds, 2008).

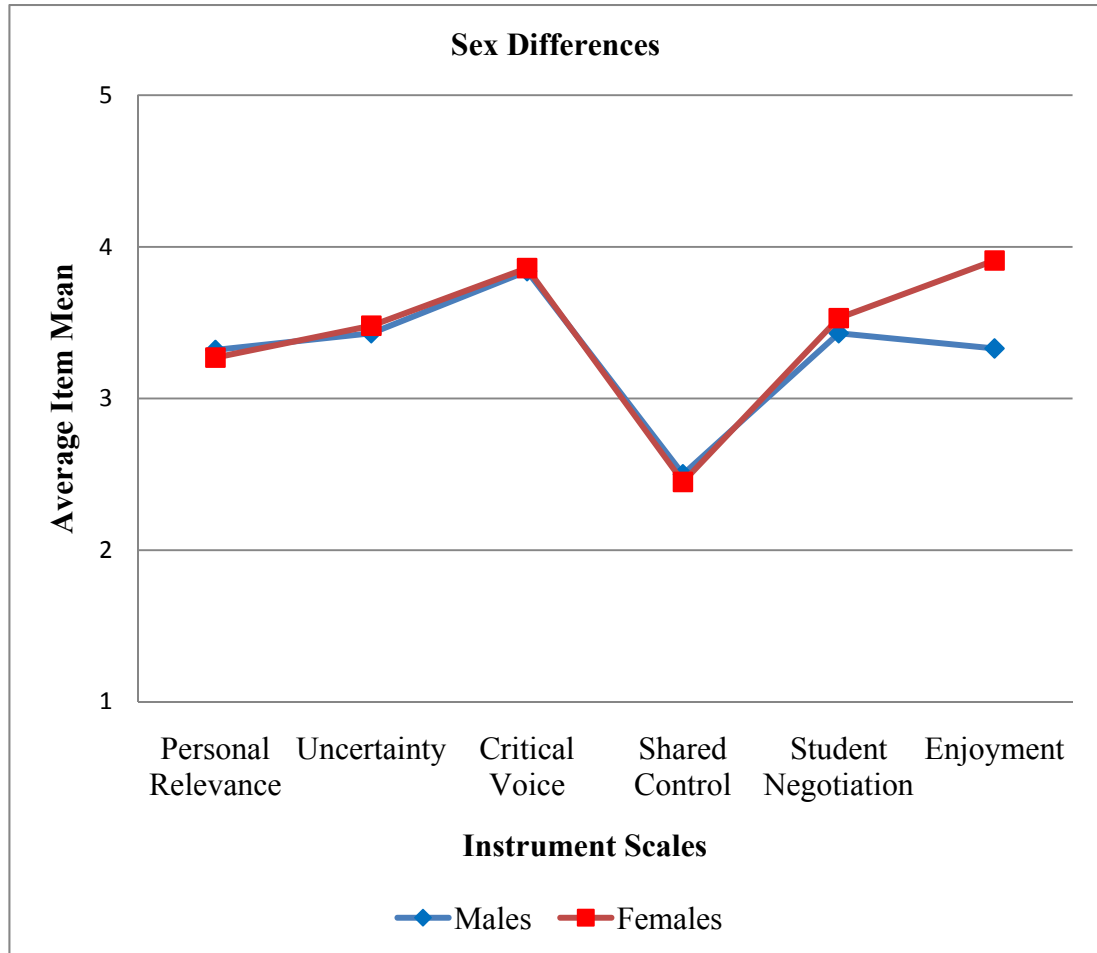*Figure 4.1.*   Sex differences for each classroom environment and attitude scale.

Figure 4.1 provides a graphical representation of the mean scores for males and females on the CLES scale and the Enjoyment scale of the TOSRA. The graph reinforces the pattern of findings in which males and females reported similar perceptions of their learning environment, but in which females enjoyed their classrooms more than males.

4.4.2 Age Differences

Table 4.4 shows that age differences were statistically significant for the two CLES scales of Shared Control and Student Negotiation and also for Enjoyment. Effect sizes, or the magnitudes of the differences between two groups, ranged from 0.21 to 0.29 standard deviations for these three scales and therefore were modest in magnitude. Cohen (1988, p. 25) defined effect sizes as small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$), with d being the difference between the means divided by the pooled standard deviation of the group.

Table 4.4. **Average Item Mean, Average Item Standard Deviation and Age Difference (Effect Size and MANOVA Results) for Each Classroom Environment and Attitude Scale**

Scale	Average Item Mean		Average Item SD		Difference	
	<25 years	>25 years	<25 years	>25 years	Effect Size	*F*
Personal Relevance	3.29	3.28	0.87	0.80	0.01	0.05
Uncertainty	3.46	3.46	0.79	0.84	0.00	0.05
Critical Voice	3.84	3.88	0.86	0.95	-0.04	0.00
Shared Control	2.43	2.65	1.06	1.15	-0.21	6.80**
Student Negotiation	3.54	3.28	1.02	1.08	0.25	4.23*
Enjoyment	3.80	3.99	0.66	0.63	-0.29	4.44*

*$p<0.05$, **$p<0.01$
The total sample of 544 students consisted of 435 students aged less than 25 years and 109 students aged more than 25 years.

As Table 4.4 shows, younger students (less than 25 years) perceived a higher level of Student Negotiation than older students (25 years or older). However, older students had higher Shared Control and Enjoyment scores than did younger students. The interpretation of the findings in Table 4.4 is that, for the Student Negotiation scale, younger students perceived more opportunities to explain and justify to other students their newly-developing ideas and to reflect on the viability of their own and

other students' ideas. However, for the Shared Control scale, students older than 25 perceived more involvement with their teachers in the design and management of the learning activities, in determining and applying of assessment criteria and in the articulation of their own learning goals than did students in the younger group. For the Enjoyment scale, older students expressed more satisfaction. Qualitative information would have been useful in providing another data stream from which to gain further insights into these findings.

Figure 4.2 provides a graphical representation of the mean scores for students younger than 25 years and for those who were 25 and older. As the graph shows, the average item means on the Personal Relevance, Uncertainty and Critical Voice scales were virtually the same for different age groups, but age differences were evident for Shared Control, Student Negotiation and Enjoyment. The interpretation is that the younger and older students in the sample shared similar views about the relevance of their learning experiences to the outside world, the existence of opportunities for them to gain knowledge from their everyday experiences that they could apply in their classes, and the degree to which their teachers were amenable to considering student input in the planning of learning activities. Both groups differed, though, in the way in which they perceived the existence of opportunities to provide feedback, their role in planning and implementing classroom activities and the degree to which they are allowed to work cooperatively with their peers. Section 4.4.4 provides a more detailed discussion of the scale scores.
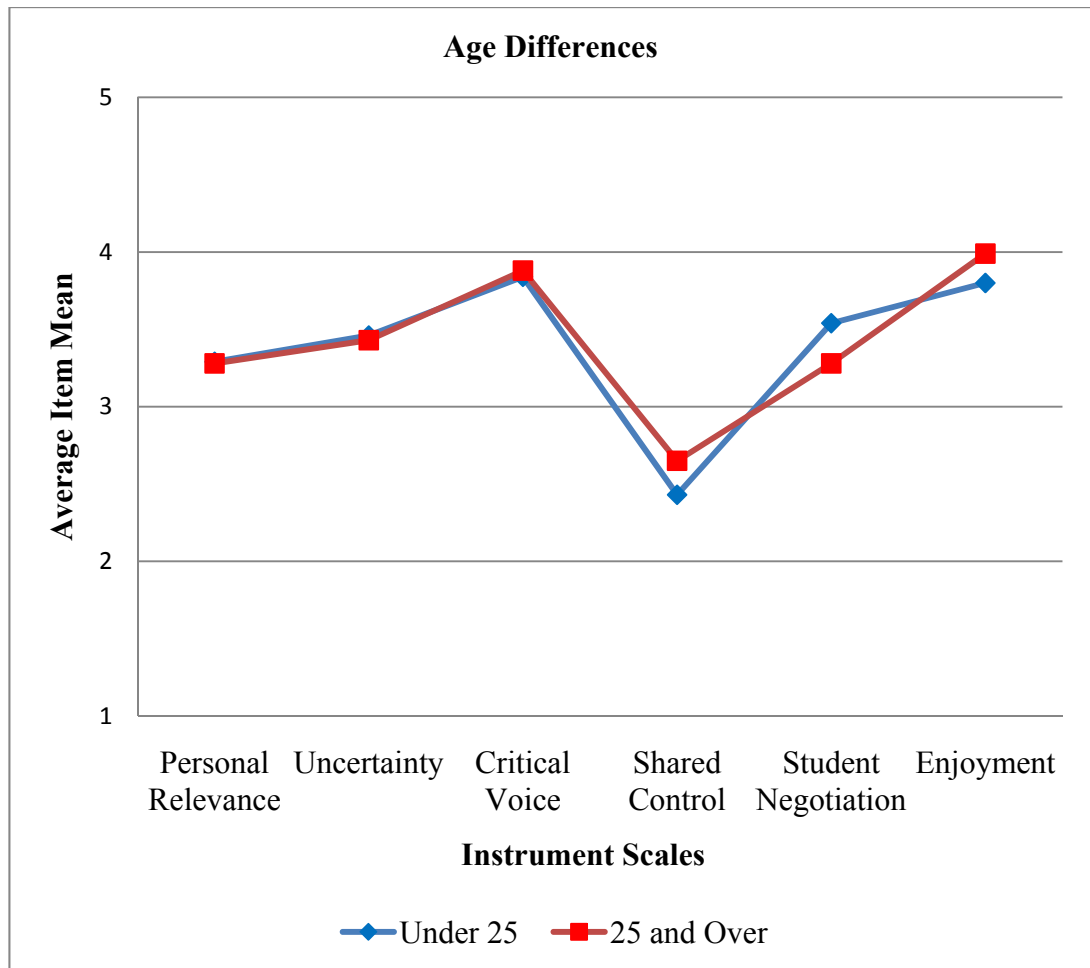
Figure 4.2.   Age differences for each classroom environment and attitude scale.

4.4.3   Ethnic Differences

As Section 3.4 in Chapter 3 established, the sample consisted of 544 students who self-identified their ethnicities as follows: 4 American Indian/Alaskan Natives, 9 Asians, 280 African Americans, 3 Native Hawaiian/Pacific Islanders, 59 Whites and 189 'Others'. Because of the small size of the other categories, it would have been impossible to conduct meaningful data analyses. As a result, I decided to combine all the other categories and compare the resulting number with the number of those who chose the African-American category. The new group comprised 264 students to compare with 280 African Americans. This approach, however, turned out to be a

limitation as it did not provide a valid basis on which to make an accurate assessment of the perceptions and attitudes of the members of the individual ethnic groups identified in the study.

Table 4.5. **Average Item Mean, Average Item Standard Deviation and Ethnic Difference (Effect Size and MANOVA Results) for Each Classroom Environment and Attitude Scale**

Scale	Average Item Mean		Average Item SD		Difference	
	African American	Other Ethnic Groups	African American	Other Ethnic Groups	Effect Size	*F*
Personal Relevance	3.29	3.29	0.83	0.88	0.00	0.01
Uncertainty	3.48	3.43	0.76	0.84	0.06	0.50
Critical Voice	3.86	3.84	0.88	0.86	0.02	0.49
Shared Control	2.43	2.51	1.07	1.10	-0.07	2.75
Student Negotiation	3.44	3.54	1.03	1.04	-0.10	0.55
Enjoyment	3.92	3.75	0.60	0.70	0.25	2.33

The total sample of 544 students consisted of 280 African Americans and 264 students of other ethnicities.

Table 4.5 shows that differences between ethnic groups (African American vs. other ethnicities) were statistically nonsignificant and generally small in magnitude for all CLES scales and for the Enjoyment scale. Figure 4.3 presents a graphical illustration of the average mean scores for African Americans and members of other ethnicities. It shows that there were only negligible differences in the way in which students of different ethnicities perceived their classroom environment and in the amount of enjoyment that they derived from the setting.

Ethnic Differences
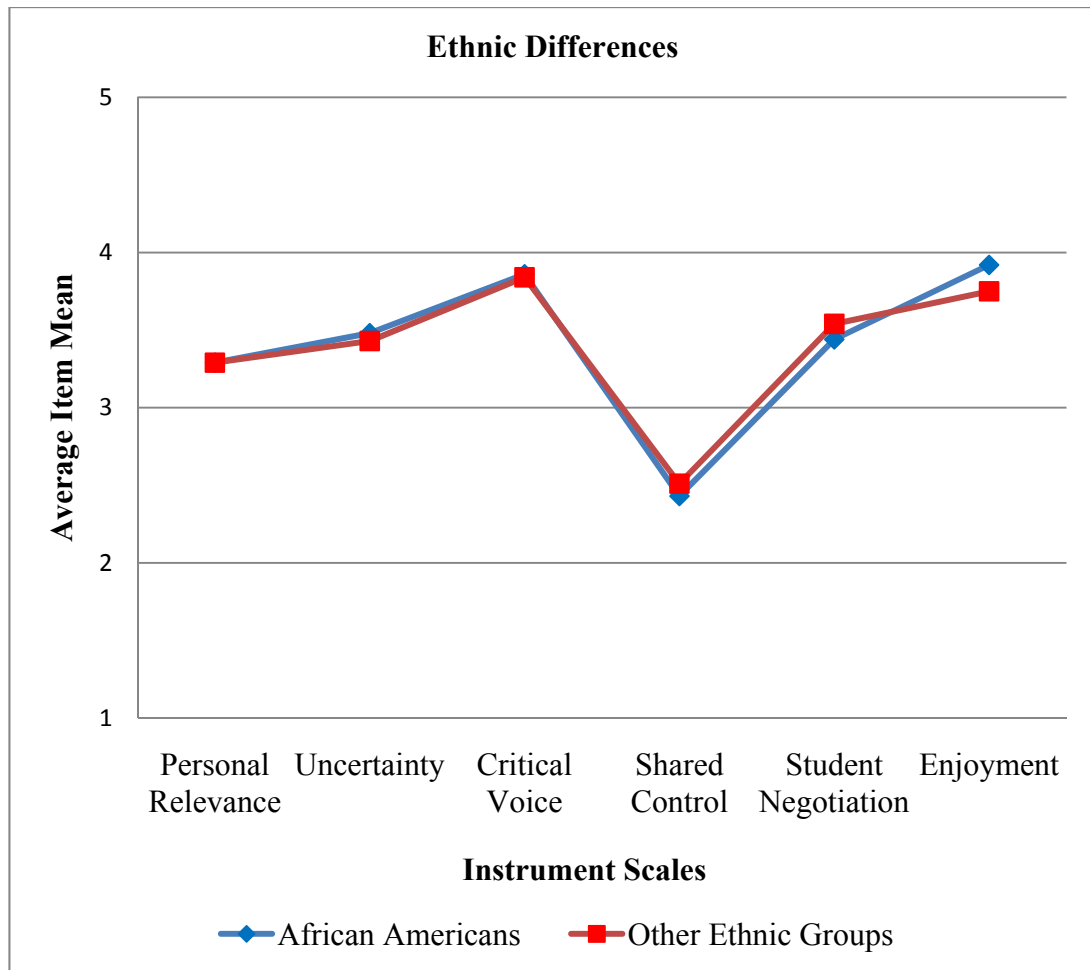
Figure 4.3. Ethnic differences for each classroom environment and attitude scale.

This surprising finding might be an artefact associated with the method of categorizing ethnicity into the two broad categories. The finding was unexpected, considering that as Johnson-Bailey (2001) observed that "overwhelmingly, studies and voluminous accounts support the existence of different experiences based on race and ethnicity" (p. 91). It might suggest that there is diffusion of differences (i.e., similarity in thinking among the various ethnic groups and that they now share the same perceptions of the classroom environment). Given the history of race relations in the United States, this possibility would be a noteworthy development for the college and a worthwhile direction for future research.

4.4.4   Discussion of Sex, Age and Ethnic Differences

Tables 4.3 to 4.5 and Figures 4.1 to 4.3 not only illustrate that sex, age and ethnic differences were generally quite small, but they also provide an overview of the average pattern of learning environment and enjoyment scores for the whole sample. The score for each item of the CLES and the TOSRA ranges from the minimum of 1 (lowest) to the maximum of 5 (highest), with a midpoint score of 3. For each CLES and TOSRA item shown in Appendix B, a score of 2 corresponds to the Seldom response, a score of 3 corresponds to the Sometimes response, and a score of 4 corresponds to the Often response.

Figures 4.1 to 4.3 shows that the average item mean on four of the five CLES scales (Personal Relevance, Uncertainty of Science, Critical Voice and Student Negotiation) and the Enjoyment of Lessons scale from the TOSRA fell between 3 and 4. This suggests that the classroom practices described in the individual items in each of these scales tended to occur with a perceived frequency of between Sometimes and Often. In the case of Critical Voice and Enjoyment, the mean was close to 4 (the Often response). On the other hand, the mean for Shared Control was the lowest of all scales, falling between 2 (the Seldom response) and 3 (Sometimes).

As noted above, except for Shared Control, all other CLES scales – Personal Relevance, Uncertainty, Critical Voice and Student Negotiation – were consistently rated above the midpoint. The data could indicate that students perceived classroom environments where teachers lean towards a constructivist teaching pedagogy and where students construct meaning for themselves. The high TOSRA scores suggest

enjoyable classroom experiences. The findings for each scale, as well as the characteristics of a constructivist classroom, are discussed in the section that follows.

Personal Relevance, which is concerned with students' perceived relevance of their educational experience to their out-of-school experiences, received an average score of 3.29 for the whole sample, which suggests that the classroom practices described in this scale's items (e.g. "My new learning starts with problems about the world outside school") were considered by students to occur with a frequency somewhat higher than Sometimes. This finding could indicate that, although students saw some link between their college courses and the world outside the classroom, some were still struggling to understand the relevance to their everyday lives. However, only further research could elucidate this possibility by providing more definitive answers.

Uncertainty was rated even more highly than Personal Relevance with an average score of 3.46 for the whole sample (i.e. with practices occurring with a frequency intermediate between Sometimes and Often). The scale assesses the extent to which students perceive that opportunities exist for them to experience course-specific knowledge as arising from their own everyday experiences, as evolving and insecure, and as culturally and socially determined. A typical item is "I learn that knowledge has changed over time". The findings could indicate that there is a growing awareness of the link between classroom instruction and real-life experiences among the respondents. Taylor, Fraser and White (1994) argue that

knowledge does not exist independently of human experience and, to a large extent, the students seemed to agree.

The mean Critical Voice score of 3.84 (i.e. with practices occurring with a frequency of approaching Often) was higher, and this applied for both sexes and across each age and ethnic classification. An inference that could be drawn from the data is that students perceived their teachers as partners in the educational process and that opportunities existed in their classrooms for students to provide feedback on academic activities and teaching approaches. In other words, students seemed to be indicating that they had a voice in what went on in their classrooms and shared some responsibility for their learning experiences. A typical item in the Critical Voice scale is "It's ok for me to speak up for my rights".

The average score for Shared Control of 2.50 was the lowest of the average scores for all CLES scales and could indicate that students perceived themselves as having a lesser role in planning and implementing activities in the classroom. That is, the practices reflected in this scale's items occurred on average with a frequency intermediate between Seldom and Sometimes. A typical Shared Control item is "I help the teacher to decide what activities to do". Future qualitative studies might be useful in shedding light on this phenomenon. Fraser and Tobin (1991) and Tobin and Fraser (1998) strongly advocate the combination of qualitative and quantitative data, noting that a triangulation of quantitative data and the other qualitative information add to the 'fruitfulness' and 'richness' of both data streams in classroom environment research.

The Student Negotiation scale assesses the extent to which opportunities exist for students to explain and justify to other students their newly-developing ideas, to understand other students' ideas and to reflect on the viability of their own and other students' ideas. A typical item reads "I talk with other students about how to solve problems". With an average score of 3.46, students perceived their classrooms as having such opportunities with a frequency intermediate between Sometimes and Often. The finding suggests that the classrooms investigated promoted good interaction and cooperation among students. Such an environment is conducive to learning.

For the Enjoyment scale, the average item mean was 3.79. The interpretation of the high score for Enjoyment is that, generally speaking, students perceived that their expectations in their classrooms were being met with a frequency approaching Often. A typical Enjoyment item is "This is one of the most interesting subjects in college". However, further research is needed to confirm whether this conclusion is accurate.

In classrooms that do not embrace constructivism, one would not expect that responses similar to the ones given above would emerge. In such classrooms, according to Gray (1997, para. 25), "an invisible and imposing, at times, impenetrable, barrier between student and teacher exists through power and practice". Students in those settings are not considered to be at the centre of the learning experience as outlined in the mission statement of Miami Dade College. Gray adds that "in a constructivist classroom, by contrast, the teacher and the student share responsibility and decision making and demonstrate mutual respect.

The democratic and interactive process of a constructivist classroom allows students to be active and autonomous learners" (para. 25). She further notes that:

> Using constructivist strategies, teachers are more effective. They are able to promote communication and create flexibility so that the needs of all students can be met. The learning relationship in a constructivist classroom is mutually beneficial to both students and teachers. Actively and interactively involved students, negotiated curriculum, and redistribution of power, control, and responsibility all contribute to a relationship between students and teacher that promotes a situation where learning thrives. With the development of a constructivist philosophy, a teacher of any discipline is able to create a classroom environment within which students are able to become autonomous learners. (para. 53)

4.5 Environment-Outcome Associations

Research question #3 involved associations between scores on the Enjoyment scale and students' perceptions of classroom environment as assessed by the five CLES scales. These associations were investigated for two units of analysis (the student and the class mean) using simple correlation analysis to determine the bivariate relationship between Enjoyment and each classroom environment scale and multiple regression analysis to determine the multivariate relationship between Enjoyment and the set of five CLES scales.

The simple correlation analysis provides information about the strength of the association between two variables, in this case, the student outcome of enjoyment and each scale of the CLES. Multivariate multiple regression provided a more parsimonious assessment of the joint influence of a set of five correlated environment scales on the outcome and reduced the Type 1 error rate (also known as false-positive error). The regression coefficient was used to identify whether a

particular environment scale was significantly related to Enjoyment scores when scores on the other four CLES scales were mutually controlled.

Table 4.6. **Simple Correlations (*r*), Multiple Correlation (*R*), and Standardized Regression Coefficients (β) for Associations Between Enjoyment and CLES Scales for Two Units of Analysis**

Scale	Unit of Analysis	Enjoyment-Environment Associations	
		r	β
Personal Relevance	Student	0.21**	0.06
	Class	0.37**	0.10
Uncertainty	Student	0.32**	0.21**
	Class	0.58**	0.39*
Critical Voice	Student	0.12**	0.02
	Class	0.46**	0.32*
Shared Control	Student	0.28**	0.15**
	Class	0.54**	0.04
Student Negotiation	Student	0.26**	0.14**
	Class	0.54**	0.34*
Multiple Correlation, *R*	Student		0.39**
	Class		0.75**

*$p < 0.05$, **$p < 0.01$
The sample consisted of 544 students in 29 classes.

Table 4.6 shows that the simple correlation (*r)* between Enjoyment and a classroom environment scale was statistically significant for every CLES scale and for both units of analysis. This table also shows that the multiple correlation (*R*) between Enjoyment and the set of CLES scales was statistically significant at both levels of analysis. In order to identify which individual CLES scales were responsible for the significant multiple correlations, the standardized regression coefficients (β) were examined.

Table 4.6 also shows that the following CLES scales were significant independent predictors of Enjoyment when the other four CLES scales were mutually controlled: Uncertainty for both units of analysis; Critical Voice with the class as the unit of

analysis; Shared Control with the individual as the unit of analysis; and Student Negotiation for both units of analysis.

It is noteworthy that every statistically significant bivariate and multivariate relationship in Table 4.6 is positive. This replicates considerable past research, which has established positive links between student outcomes and the classroom learning environment (Fraser, 2007; Fraser, Aldridge & Adolphe, 2010; McRobbie & Fraser, 1993).

The present study involving the CLES, like many other studies previously carried out in the field of classroom environment, is correlational in that it investigated associations between the psychosocial dimensions of the classroom and student outcomes. While certain trends and tendencies invariably emerge in the course of the study, care must be taken in interpreting the results. The establishment of strict causal relationships should not be assumed for any of the results presented in this section. Psychosocial factors that affect one group of subjects in a study can have distinct and separate effects on the behaviour and attitudes of another (Cooper, Goswami & Sahakian, 2009, p. 491).

4.6   Summary and Conclusions

This chapter focused on the presentation and interpretation of findings based on analyses of the quantitative data collected in the study. The sample consisted of 544 students in 29 classes. There were 226 males compared with 318 females, 435 students younger than 25 years compared with 109 who were 25 years or older, and

280 students who identified themselves as African Americans compared with 264 students who selected other ethnicities.

The chapter began with a restatement of the purposes of the study, which were (1) to determine whether the Constructivist Learning Environment Survey (CLES) and a modified version of the Enjoyment of Science Lessons scale from the Test of Science-Related Attitudes (TOSRA) were valid and reliable when used with adult learners in an urban two-year college in Florida, USA, (2) to investigate whether there were sex, age and ethnic differences in learning environment perceptions and student enjoyment and, finally, (3) to ascertain whether there were associations between the classroom learning environment and the student outcome of satisfaction. A summary of the research methods was then presented.

The first question concerned the validity of the Constructivist Learning Environment Survey (CLES) and a modified version of the Enjoyment of Science Lessons scale of Test of Science-Related Attitudes (TOSRA). Factor analysis showed that the proportion of variance ranged from 5.63% to 28.28% for different CLES scales, with a total proportion of variance at 63.88% and eigenvalues for different scales ranging from 1.52 to 7.64. For different CLES scales, the alpha reliability ranged from 0.76 to 0.93 at the student level and from 0.70 to 0.94 at the class level. For the Enjoyment scale, the reliability was 0.89 for individuals and 0.93 for class means.

The discriminant validity of different CLES scales (using the mean correlation with other scales) ranged from 0.25 to 0.31 with the student as the unit of analysis and

from 0.23 to 0.47 for class means. These values of the discriminant validity suggest some overlap in raw scores on different CLES scales, but the factor analysis provided strong support for the factor structure and independence of factor scores. Results from analysis of variance (ANOVA) suggested that each CLES scale could differentiate between the perceptions of students in the 29 different classrooms. The eta^2 statistic, which is an estimate of the strength of association between class membership and CLES scale scores, ranged from 0.07 to 0.17 for different scales. With the exception of the Uncertainty scale, each CLES scale differentiated significantly ($p<0.01$) between classrooms.

The second research question asked whether there were sex, age and ethnic differences in learning environment perceptions and student enjoyment. A three-way MANOVA for sex, age and ethnic differences in classroom environment perceptions and enjoyment revealed a statistically significant sex difference associated with a large effect size of 0.88 standard deviations, suggesting that females enjoyed their classes significantly more than did males. Also, age differences were statistically significant for Shared Control and Student Negotiation and for the Enjoyment scale. Effect sizes for these scales ranged from 0.21 to 0.29. Students older than 25 years had significantly higher Shared Control and Enjoyment scores, but lower Student Negotiation scores than did students younger than 25 years. Differences between African Americans and students of other ethnicities were statistically nonsignificant for any learning environment scale or for enjoyment. Effect sizes for ethnicity were of small magnitude ranging from 0.02 to 0.25.

The third research question focused on associations between scores on the revised Enjoyment scales from the TOSRA and students' perceptions of classroom environment as assessed by the five CLES scales. The student and the class mean were used as the two units of analysis. The simple correlation between Enjoyment and each classroom environment scale was statistically significant for every CLES scale and for both units of analysis. Also, the multiple correlation between Enjoyment and the set of CLES scales was statistically significant at both levels of analysis. Standardized regression coefficients showed that Uncertainty for both units of analysis, Critical Voice with the class as the unit of analysis, Shared Control with the individual as the unit of analysis, and Student Negotiation for both units of analysis were significant independent predictors of Enjoyment when the other four CLES scales were mutually controlled. Every statistically significant bivariate and multivariate relationship was found to be positive, replicating the pattern of positive outcome-environment associations found in considerable past research (Fraser, 2007).

The next and final chapter discusses the major findings of the study, its major contribution to the field of learning environment, its limitations and recommendations and suggestions for future research.

Chapter 5

DISCUSSION AND CONCLUSIONS

5.1   Introduction

This study's three research objectives were (1) to check whether the Constructivist Learning Environment Survey (CLES) and a modified version of the Enjoyment of Science Lessons scale of the Test of Science-Related Attitudes (TOSRA) were valid when used with adult learners in an urban two-year college in South Florida, (2) to investigate sex, age and ethnicity differences in learning environment perceptions and enjoyment and (3) to examine whether there are associations between the classroom learning environment and student enjoyment.

Because people often form strong opinions about others based solely upon observing variables such as sex, age and ethnicity, consequently, they make generalizations and develop certain expectations, which then inform how they interact with members of various groups. However, according to Fraser (1986b), "students' perceptions, because they are the determinants of student behaviour more so than the real situation, can be more important than observed behaviours" (p. 3). Therefore, in any learning environment, but especially in one as diverse as South Florida's, it is unwise for an educator to make assumptions about the behaviour of his or her students simply based upon their demographic characteristics. It is for this reason that this study was conceived in an attempt to clarify the ways in which college

students of mixed demographic backgrounds perceive and respond to their learning environment.

The research was conducted at an urban two-year or junior college in Florida, with a sample of 544 students in 29 randomly-selected classes. The Constructivist Learning Environment Survey (CLES) was used to assess the way in which students perceived their classroom environments, whereas a modified version of the Enjoyment of Science Lessons scale from the Test of Science Related Attitudes (TOSRA) was used to assess students' attitudes toward the subject taught in the classes surveyed. Section 5.1 is the introduction to the present chapter. Section 5.2 presents an overview of the thesis. The major findings of the study are summarised and discussed in Section 5.3. Its major contributions are outlined in Section 5.4. Section 5.5 explains its limitations. Recommendations and suggestions for future research are made in Section 5.6. The chapter ends with a summary in Section 5.7.

5.2 Overview of the Thesis

Chapter 1 provided an encapsulation of the thesis as a whole. It presented information about Miami Dade College, the institution in which the study was conducted and highlighted the Fall 2008 demographic profile of the student body according to age, sex and ethnicity – the most recently available enrolment data published by the college. This chapter also introduced constructivism, perceptions of the learning environment, the determinants of sex, age and ethnicity and the theoretical underpinnings which informed and guided the design of the research. In addition, the chapter introduced the Constructivist Learning Environment Survey

(CLES) and the Test of Science-Related Attitudes (TOSRA), the instruments that were used to collect my data. Finally, Chapter 1 also described the significance of the study, defined unfamiliar terms used throughout the discourse, acknowledged and addressed the limitations of the study and outlined the research questions.

Chapter 2 thematically reviewed contemporary literature to show how the present study was linked to the work of previous researchers who contributed to the field of learning environments. It began with a discussion of the epistemological relevance of the theoretical framework of the study, and it continued by briefly exploring the history of the emergence of the field of learning environments and instruments developed to assess classroom climate. The chapter concluded with an examination of past literature dealing with the role that students' sex, age and ethnicity play in the way in which the students perceive their learning environment and enjoy their class.

Chapter 3 provided information on the research design of the study. It described the sample of participants and the method of selection. The sample of 544 students in 29 randomly-selected classes consisted of 226 males and 318 females, 435 students who were less than 25 years of age and 109 who were 25 years or older, and 280 students who identified themselves as African Americans compared to 264 who selected other ethnicities. Sections of the chapter presented a more detailed description of the CLES and the TOSRA, the two instruments that were selected for use in the study, and how they were administered. The chapter concluded with a discussion of data-collection procedures, together with the data-analysis methods used in answering each of the research questions.

Chapter 4 reported analyses and results for each of my research questions, starting with the validity and reliability of the CLES and the modified Enjoyment of Science Lessons scale of the TOSRA. The chapter also reported sex, age and ethnic differences in learning environment perceptions and enjoyment and concluded with a section that reported the associations between the classroom learning environment and enjoyment. The results from Chapter 4 are summarized in more detail in Section 5.3 of this chapter.

Chapter 5 now provides some closing arguments, beginning in Section 5.1 with an introduction that reviews and justifies the reasons for conducting the study. This is followed by Section 5.2, which provides an overview of the thesis as a whole and a brief summary of the highlights of each chapter. Section 5.3 summarizes the major findings of the study and the statistical inferences drawn and their links to previous research. Contributions of the study to the field of learning environment and to the field of teaching and learning are given Section 5.4. Numerous important limitations of the study are discussed in Section 5.5, whereas recommendations and suggestions for future research are offered in Section 5.6. The chapter concludes with a summary in Section 5.7.

5.3   Major Findings of the Study

The first research question concerned the validity and reliability of the survey instruments, namely, the CLES and the TOSRA. Principal axis factoring followed by varimax rotation with Kaiser normalization confirmed the *a priori* structure of the CLES, which is comprised of 30 items. After eliminating Items 3, 6, and 7, all

remaining items had a loading of at least 0.40 on their own scale and less than 0.40 on all other CLES scales. The total proportion of variance was 63.88%. Eigenvalues for different scales ranged from 1.52 to 7.64.

Statistical analysis of the data indicated sound internal consistency reliability (Cronbach's alpha coefficient) for each of the five scales of the CLES and the Enjoyment scale of the TOSRA. Analyses were performed separately for the individual student and the class mean as units of analysis. For different CLES scales, the alpha reliability ranged from 0.76 to 0.93 at the student level and from 0.70 to 0.94 at the class level. For the Enjoyment scale, the reliability was 0.89 for individuals and 0.93 for class means.

When the mean correlation of each CLES scale with the other scales was calculated for two units of analysis (the student and the class), it was revealed that the discriminant validity of different CLES scales ranged from 0.25 to 0.31 with the student as the unit of analysis and from 0.23 to 0.47 for class means. This analysis suggested that raw scores on CLES scales assess independent, but somewhat overlapping, aspects of classroom environment. However, the factor analysis attested to the independence of the factor scores.

Finally, an analysis of variance (ANOVA) demonstrated that each CLES scale could differentiate between the perceptions of students in the 29 different classes. The eta^2 statistic, which represents the proportion of variance in scale scores, ranged from 0.07 to 0.17. With the exception of the Uncertainty scale, each CLES scale differentiated significantly ($p<0.01$) between classrooms. Overall, these findings

replicate validity results reported for the CLES and TOSRA in various countries, including Korea (Kim, Fisher & Fraser, 1999), the United States (Nix, Fraser & Ledbetter, 2005; Peiro & Fraser, 2008), Australia and Taiwan (Aldridge, Fraser, Taylor & Chen, 2000) and South Africa (Sebela, Aldridge & Fraser, 2004).

In answering the second research question about sex, age and ethnic differences in learning environment perceptions and enjoyment, a three-way MANOVA was undertaken. The five scales of the CLES and the Enjoyment scale of the TOSRA served as the correlated dependent variables. Wilks' lambda criterion (Λ) revealed statistically significant sex, age and ethnic differences for the set of dependent variables as a whole, but all interactions between variables were nonsignificant. Therefore, the univariate ANOVA results were interpreted separately for each independent variable. The analysis revealed no significant sex difference for any CLES scale, but showed that females expressed greater enjoyment in their classrooms than did males. This statistically significant sex difference on the Enjoyment scale was associated with a large effect size of 0.88 standard deviations for the sample of 226 males and 318 females.

Also, age differences were statistically significant for the two CLES scales for Shared Control and Student Negotiation and also for Enjoyment. Effect sizes, ranging from 0.21 to 0.29 standard deviations for age differences for these three scales, were modest in magnitude. Younger students (less than 25 years) perceived a higher level of Student Negotiation than older students (25 years and older). However, older students had higher Shared Control and Enjoyment scores than did

younger students for the sample of 435 students aged less than 25 years and 109 students aged 25 years or more.

Finally, no statistically significant differences emerged between ethnic groups (African American vs. other). Effect sizes for ethnic differences were small, ranging from -0.07 to 0.06 standard deviations for all the scales of the CLES and 0.25 standard deviations for the Enjoyment scale of the TOSRA for the sample of 280 African Americans and 264 students of other ethnicities.

The third and final research question centred on associations between scores on the Enjoyment scale and students' perceptions of classroom environment as assessed by the five CLES scales using two units of analysis (the student and the class mean). Simple correlation analyses were used to determine the bivariate relationship between Enjoyment and each classroom environment scale, whereas multiple regression analyses were used to determine the multivariate relationship between Enjoyment and the set of five CLES scales.

The simple correlation between Enjoyment and a classroom environment scale was statistically significant for every CLES scale and for both units of analysis. The multiple correlation between Enjoyment and the set of CLES scales was statistically significant at both levels of analysis. Inspection of regression coefficients revealed that, with the other four CLES scales mutually controlled, the following CLES scales were significant independent predictors of student enjoyment: Uncertainty for both units of analysis; Critical Voice with the class as the unit of analysis; Shared

Control with the individual as the unit of analysis; and Student Negotiation for both units of analysis.

It is noteworthy that every statistically significant bivariate and multivariate relationship that emerged in these analyses was positive. Taken together, this suggests that students enjoyed classes with more emphasis on constructivist aspects of teaching and learning approaches and that causal relationships exist among the independent variables of sex, age and ethnicity and the way in which students perceive their learning environment and their levels of satisfaction. Furthermore, the findings of positive associations between student outcomes and the classroom learning environment replicate the results of a considerable number of past research studies (Aldridge, Fraser & Sebela, 2004; Aldridge, Fraser, Taylor & Chen, 2000; Kim, Fisher & Fraser, 1999; Nix, Fraser & Ledbetter, 2005; Peiro & Fraser, 2008).

5.4   Contributions of the Study

The present study is one of many in the growing field of learning environment research, but it is unique because it focused on the learning environment for diverse adult learners at the junior college level. Extensive research using a variety of instruments developed to measure associations between students' perceptions of their learning environments and their attitude and performance has been undertaken at the primary and secondary levels of education, but not as much at the tertiary level.

In addition, this study has added further evidence to the large body of knowledge gathered in studies conducted around the world that have consistently supported the validity and reliability of the CLES and the TOSRA as instruments that are versatile in their transnational and cross-disciplinary application and their ability to help educators to make informed assessments about their unique educational settings regardless of whether the educational level is primary, secondary or post-secondary.

Furthermore, few past studies have investigated the influence of student sex, age and ethnicity, either individually or together, as determinants of learning environment perceptions. The results of this study, therefore, provide some insight into the relationship between the demographic factors of sex, age and ethnicity and students' classroom environment perceptions.

5.5   Limitations of the Study

This study has focused on the determinants and effects of the learning environment in college classes. In many similar studies, researcher bias in interpreting the results has been a distinct possibility and is probably one of the limitations of this study. Although I have been careful to be objective, it is possible that some preconceived notions that I might have had about the problem could have affected my interpretation of the data and the way in which I have reported the findings.

Another limitation of the study was the particular demographic characteristics of the subjects: 544 students in 29 classes in which there were 226 males and 318 females. Of the sample, 435 students were less than 25 years of age and 109 were 25 years or

older; and 280 identified themselves as African Americans while the remaining 264 students listed membership in a variety of other ethnic groups. The small size of the sample and the definition of ethnicity were concerns. Therefore, what might be true for this particular group of students in their unique academic setting might not be true of other types of students in other settings.

As discussed earlier in Section 1.3.2.3, the meaning of 'ethnicity' is neither clear nor distinct. It varies from racial characteristics to cultural background. In addition, no independent or objective measure exists to verify the categories which students select. Thus, without a way to reduce the degree of subjectivity in the data-reporting and data-collection, I cannot guarantee that my results for ethnicity are completely independent and accurate and have not led to erroneous assumptions. The imprecise definition of the term 'ethnicity' is a limitation.

A third limitation in this study was its cross-disciplinary and its cross-sectional nature. While the students in the sample were all enrolled in composition and reading courses and thus fell under the umbrella of subjects considered to belong to the humanities, the instruments used, the CLES and the TOSRA, were originally designed for and validated with students in science and mathematics classes. Additionally, previous use of the instruments has been more extensive in the secondary school setting than in the college setting. Therefore, there could have been some issues in how concepts carry over from one discipline to another and from one educational level to the other. Further research using the same instruments in the college setting could clarify the relationships explored in this study.

A fourth limitation was the exclusion of interviews in this study. Fraser and Tobin (1991) note "the fruitfulness of confluence of qualitative and quantitative research traditions in classroom environment research" (p. 290) and strongly advocate their combination. They note that triangulation of quantitative classroom climate data and the other qualitative information add to the 'fruitfulness' and 'richness' of both data streams in classroom environment research. Thus, interview questions designed to explore personal perceptions of teachers and students, along with researcher observations, would have been useful in providing qualitative information that might have clarified and enhanced the findings of the survey instruments.

Open-ended interviews used to obtain important information that do not fit any pre-determined set of responses would have provided direct, personal contacts with respondents and would have allowed frank informal expressions of opinions. Patton (2002) observes that a mix of qualitative and quantitative data gathering enriches evaluations and that open-ended comments provide a way to elaborate and contextualize statistical 'facts'. Unfortunately, scheduling conflicts, the duration of college classes, and the time in the semester when the surveys were administered made extensive interviewing of a cross-section of the students in the sample impossible. It would be useful in future research, therefore, to include a qualitative component.

A fifth limitation is the likelihood that some data might have been collected from the same student in two different classes. A relatively small number of students who were enrolled in both reading and writing classes might have taken the survey twice. There was no way to know because the survey was anonymous and students did not

have to disclose whether they had taken it in another class. In future research into the same theme, provision should be made for such students to identify themselves and be excused from participating a second time.

Having only one student outcome was also a limitation. In addition to enjoyment or satisfaction, the inclusion of other student outcomes from both the affective and cognitive domains (e.g., achievement and retention rates) could have provided richer information about sex, age and ethnic differences. Both, however, would have required a scope much broader than that which the present study was designed to cover.

In summary, the generalizability of the findings of the research across different settings is limited by sampling characteristics, the relatively small sample size and problems with aspects of the data-collection method. As a result, the findings might only be applicable to non-traditional adult learners in an urban two-year college setting in South Florida. Future studies designed to replicate or refute my research findings should attempt to include a greater number of subjects, more carefully define the population characteristics and employ more objective measures.

5.6   Recommendations and Suggestions for Future Research

Although potential limitations to this study have already been discussed, nevertheless, it has made worthwhile contributions to the field of learning environments. However, future studies designed to investigate sex, age and ethnicity as determinants of students' perceptions of learning environment and their level of

satisfaction should ideally include a qualitative component. A mixed-method approach would add the voices of the respondents in the sample, thereby providing another stream of data that would enrich the statistical findings.

Given the small sample size and the fact that the survey was administered to students in only two disciplines, it would also be illuminating for future researchers to conduct studies using larger and more diverse samples from a wider range of disciplines in more post-secondary institutions. This step would improve the generalizability of the findings.

As alluded to in Section 5.5, future studies would benefit from the inclusion of a broader range of student outcomes (e.g., achievement) than just the enjoyment outcome used in my study.

Because the duration of college courses is relatively short, care must be taken in choosing the most opportune time to conduct surveys. Administered too early in the semester, responses to surveys perhaps would not accurately capture students' true opinions as they would not have enough time to become fully informed about their instructors' teaching styles and the resulting classroom climate that is created. Likewise, done too late in the semester, the surveys might have to be rushed to avoid competing for the attention of students anxious about final examination preparations and instructors busy complying with end-of-term procedures. The recommendation, then, would be for the surveys to be administered perhaps three weeks before the end of the term.

Finally, researchers using the CLES and the TOSRA in the future should create and manage the surveys online. Software (e.g., Qualtrics, Zoomerang and Survey Monkey) is available for designing and creating a variety of survey questionnaires to satisfy individual needs, interests and idiosyncrasies. Migrating to this format would provide the researcher with significant advantages in terms of the flexibility of the survey administration, in using email to communicate with respondents, in tracking respondents as they complete the surveys, in tabulating or exporting data for analysis and in creating instant reports. Such innovation would expedite turnaround time and eliminate the need to score the questionnaires by hand and then upload the data to a processing file, which are both arduous and time-consuming tasks.

5.7 Summary of the Chapter

Analyses of the responses of 544 mature college students in a South Florida to the CLES and TOSRA provided answers to my three research questions concerning (1) the validity of questionnaires, (2) sex, age and ethnicity differences in learning environment and attitudes and (3) attitude-environment associations:

- The CLES and the TOSRA were valid measures of students' perceptions of classroom environment and attitudes, respectively, when used with adult learners in a post-secondary setting. The findings replicate numerous previous transnational and cross-disciplinary studies conducted in primary, secondary and post-secondary education institutions.

- Females enjoyed their classes significantly more than did males, which replicates similar findings reported by Calabrese and Poe (1990), Hoang (2008) and Sullivan, Ricci and Reynolds (2008).

- Students older than 25 had significantly higher scores on the Shared Control (student participation in planning, conduct and assessment of learning) and Enjoyment scales, but significantly lower scores on Student Negotiation (involvement with other students in assessing viability of new ideas) than did those younger than 25. Effect sizes, ranging from 0.21 to 0.29 standard deviations for these three scales, were modest in magnitude.

- No significant difference among ethnic groups emerged for any learning environment scale or for Enjoyment. Possibly this finding arose because of the categorization of the sample into two groups – African Americans and other ethnicities – because so few respondents selected the other ethnic groups besides African American.

- Positive associations were found between student enjoyment of their classes and their perceptions of the classroom environment, thus replicating past research.

A major contribution of this study is that it has provided educational researchers with further evidence of the reliability and validity of instruments (CLES and TOSRA) to assess the classroom environment and attitudes. Researchers and educational practitioners, therefore, can take comfort in the fact that the instruments function as they are designed to do and are adaptable to a wide variety of locations and educational settings.

Another important contribution of the study to the field of learning environments research is that, in investigating college classroom environments, it has established tentative associations between the psychosocial climate and student enjoyment among a diverse group of college students. However, further replication studies involving other samples and a broader range of student outcomes are warranted in the future to add strength to the findings reported in this study.

In a diverse setting such as South Florida, it is neither unusual nor infrequent to find students across the education spectrum whose views diverge on many issues. Therefore, to find data that suggest that an ethnically-mixed group of 544 students in 29 classes viewed their learning environment in a similar way can be interpreted in different ways. It could suggest that the students did not perceive that their ethnic differences played a role in their interactions in the classroom environment or, according to Logan (2003), who cited Moos (1979) and Noddings (1990), they have reached the point where one group has accepted the norms and values of the other or have somehow arrived at a compromise.

Finally, the study is unique because it focused on the learning environment for diverse adult learners at the junior college level. Furthermore, few past studies have investigated the influence of student sex, age and ethnicity on learning environment perceptions. The results of this study provide some evidence to support the assertion that demographic factors – in this case, sex – can influence the way in which students perceive their learning environments. Knowledge of the potential impact of the factors in classroom environments could help teachers and educational planners

who serve diverse populations to be more sensitive to student needs and thus make

more informed pedagogical decisions.

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Appendix A

Research Authorization Request

INTEROFFICE MEMORANDUM

TO: Dr. Jose Vicente, Campus President

FROM: Denton Tulloch

SUBJECT: Authorization to Conduct Research

DATE: 5/12/2011

I respectfully request your permission as outlined in MDC Procedure 1321 to conduct research on North Campus for a doctoral dissertation that I am currently writing.

The title of the project is Determinants and Effects of the Learning Environment in College Courses. The purpose is to investigate whether there are associations between age, ethnicity and sex differences in learning environment perceptions and student outcomes (achievement and attitudes) among adult students in the college setting.

I have attached copies of the following documents:

- Application for Confirmed Candidature
- Ethics Approval
- Participant Information
- Consent Form
- Survey Instruments

The Participant Information sheet and the Consent Form address confidentiality and data storage and well as the estimated intrusiveness of the study.

The potential benefit of the research for MDC is that it can help enrich a teacher's understanding of the dynamics at work in the classroom environment and provide guidance for teaching innovations to enhance students' learning experiences.

Please advise me should you need any further documentation or explanation in consideration of this request.

I look forward to hearing from you.

Participant Information Sheet

My name is Denton Tulloch, and I am currently completing a piece of research for my PhD in science education at Curtin University of Technology.

Purpose of Research

I am investigating classroom environments.

Your Role

I am interested in finding out some general details about you, such as age range, ethnicity, and gender. I would also like to find out your response to a number of statements about your perception of the classroom environment. The survey will take approximately 35 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 I will only have access to this. The documents will not have your name or any other identifying information on it and in adherence to university policy, it will be kept in a locked cabinet for five years before it is destroyed.

Further Information

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee and approved by Miami Dade College. If you would like further information about the study, please feel free to contact me at (305) 237-1837 or by email: dtulloch@mdc.edu.

Consent Form

- I understand the purpose and procedures of the study.

- I have been provided with the participant information sheet.

- I understand that the procedure itself may not benefit me.

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

- I understand that no personal identifying information like my name and address will be used and that all information will be securely stored for 5 years before being destroyed.

- I have been given the opportunity to ask questions.

- I agree to participate in the study outlined to me.

Signature _____

Date_____

Appendix B

Classroom Environment and Attitude Survey,

Including Demographic Information

- *TOSRA*

Enjoyment Scale from Test of Science-Related Attitudes (Modified Version)

Adapted from Fraser (1981). Used in this study and included in this thesis with the author's permission.

- *CLES*

Constructivist Learning Environment Survey – Actual Form

From Taylor, Fraser and Fisher (1997). Used in this study and included in this thesis with the authors' permission.

Enjoyment of Lessons Survey

Directions:

1. This survey contains a number of statements about this subject.

2. Bubble in the most suitable response from the choices given for each item that you think most accurately reflects your feelings.

3. Cross out and circle another response if you change your mind about an answer.

4. Although some items are fairly similar, please respond to each one.

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1. Lessons in this subject are fun.	O	O	O	O	O
2. I like lessons in this subject.	O	O	O	O	O
3. There should be more lessons in this subject this week.	O	O	O	O	O
4. Lessons in this subject do not bore me.	O	O	O	O	O
5. This is one of the most interesting subjects in college.	O	O	O	O	O
6. Lessons in this subject are not a waste of time.	O	O	O	O	O
7. I really enjoy going to lessons in this subject.	O	O	O	O	O

8. The material covered in lessons in   ○   ○   ○   ○   ○

    this subject is interesting.

9. I look forward to lessons in this   ○   ○   ○   ○   ○

    subject.

10. I would enjoy college more if there   ○   ○   ○   ○   ○

    were more lessons in this subject.

Constructivist Learning Environment Survey

Actual Form

Directions for Students

This questionnaire contains statements about practices that could take place in this class. You will be asked how often each practice takes place. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Think about how well each statement describes what this class is like for you.

Draw a circle around

1	if the practice takes place	Almost Never
2	if the practice takes place	Seldom
3	if the practice takes place	Sometimes
4	if the practice takes place	Often
5	if the practice takes place	Almost Always

Be sure to give an answer for all questions. If you change your mind about an answer, just cross it out and circle another.

Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Practice Example

Suppose you were given the statement 'I choose my partners for group discussion.' You would need to decide whether you choose your partners 'Almost always,' 'Often,' 'Sometimes,' 'Seldom,' or 'Almost never.' If you selected 'Often,' then you would circle the number 4 on your questionnaire.

Learning about the world	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Almost Always**
In this class …					
1. I learn about the world outside of school.	1	2	3	4	5
2. My new learning starts with problems about the world outside of school.	1	2	3	4	5
3. I learn how this subject can be part of my out-of-school life.	1	2	3	4	5

	Learning about the world *In this class …*	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Almost Always**
4.	I get a better understanding of the world outside of school.	1	2	3	4	5
5.	I learn interesting things about the world outside of school.	1	2	3	4	5
6.	What I learn has nothing to do with my out-of-school life.	1	2	3	4	5
	Learning about this subject *In this class …*	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Almost Always**
7.	I learn that this subject cannot provide perfect answers to problems.	1	2	3	4	5
8.	I learn that knowledge has changed over time.	1	2	3	4	5
9.	I learn that this subject is influenced by people's values and opinions	1	2	3	4	5
	In this class …					
10.	I learn that people in other cultures use concepts taught in this subject.	1	2	3	4	5
11.	I learn that the modern form of this subject is different from the form used long ago.	1	2	3	4	5
12.	I learn that this subject is about creating theories.	1	2	3	4	5

Learning to speak out	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Almost Always**
In this class …					
13. It's OK for me to ask the teacher 'Why do I have to learn this?'	1	2	3	4	5
14. It's OK for me to question the way I'm being taught.	1	2	3	4	5
15. It's OK for me to complain about teaching activities that are confusing.	1	2	3	4	5
In this class …					
16. It's OK for me to complain about anything that prevents me from learning.	1	2	3	4	5
17. It's OK for me to express my opinion.	1	2	3	4	5
18. It's OK for me to speak up for my rights.	1	2	3	4	5

Learning to learn	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Almost Always**
In this class …					
19. I help the teacher plan what I'm going to learn.	1	2	3	4	5
20. I help the teacher to decide how well I am learning.	1	2	3	4	5
21. I help the teacher to decide which activities are best for me.	1	2	3	4	5

	Learning to learn *In this class …*	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Almost Always**
22.	I help the teacher to decide how much time I spend on learning activities.	1	2	3	4	5
23.	I help the teacher to decide which activities I do.	1	2	3	4	5
24.	I help the teacher to assess my learning.	1	2	3	4	5

	Learning to learn *In this class …*	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Almost Always**
25.	I get the chance to talk to other students.	1	2	3	4	5
26.	I talk with other students about how to solve problems.	1	2	3	4	5
27.	I explain my understandings to other students.	1	2	3	4	5
	In this class …					
28.	I ask other students to explain their thoughts.	1	2	3	4	5
29.	Other students ask me to explain my ideas.	1	2	3	4	5
30.	Other students explain their ideas to me.	1	2	3	4	5

Demographic Information

Please check the box beside the category that most accurately describes you.

Gender

Male   ☐   Female ☐

Age Range

- 18-24   ☐
- 25-34   ☐
- 35-44   ☐
- 45-54   ☐
- 55-64   ☐
- 65+   ☐

Race/Ethnicity

- American Indian or Alaskan Native   ☐
- Asian   ☐
- Black or African American   ☐
- Native Hawaiian or Pacific Islander   ☐
- White   ☐
- Other   ☐

For office use only

Course: _____ Date: _____/_____/2009

Appendix C

The New Constructivist Learning Environment Survey

Each scale of the new version of the Constructivist Learning Environment Survey (CLES) was designed to obtain measures of students' perceptions of the frequency of occurrence of five key dimensions of a *critical constructivist* learning environment. The CLES contains 30 items altogether, with six items in each of the five scales. The response alternatives for each item are Almost Always, Often, Sometimes, Seldom, and Almost Never.

<u>Personal Relevance</u>

This scale focuses on the connectedness of school science to students' out-of-school experiences, and with making use of students' everyday experiences as a meaningful context for the development of students' scientific and mathematical knowledge.

<u>Uncertainty</u>

This scale assesses the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory-dependent inquiry involving human experience and values, and as evolving, non-foundational, and culturally and socially determined.

<u>Critical Voice</u>

This scale examines the extent to which a social climate has been established in which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods, and to express concerns about any impediments to their learning.

<u>Shared Control</u>

This scale is concerned with students being invited to share with the teacher control of the learning environment, including the articulation of learning goals, the design and management of learning activities, and the determination and application of assessment criteria.

<u>Student Negotiation</u>

This scale assesses the extent to which opportunities exist for students to explain and justify to other students their newly developing ideas, to listen attentively and reflect on the viability of other students' ideas and, subsequently, to reflect self-critically on the viability of their own ideas.

Extract from *Monitoring Constructivist Classroom Learning Environments*
Peter C. Taylor, Barry J. Fraser and Darrell L. Fisher (1997)