

THE EFFECTS OF LIVE PLANTS AND WINDOWS ON PEOPLES' USE OF  
INTERIOR STUDY SPACES AND THEIR PERCEIVED QUALITY OF LIFE AND  
STRESS LEVELS

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by

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## TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS .....	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES.....	vii
ABSTRACT.....	xii
CHAPTER	
I. INTRODUCTION.....	1
II. REVIEW OF LITERATURE.....	7
III. METHODOLOGY .....	24
IV. RESULTS.....	31
V. SUMMARY, CONCLUSION, AND RECOMMENDATIONS.....	75
APPENDIX A: CONSENT FORM .....	82
APPENDIX B: USE OF SPACE LOG SHEET .....	85
APPENDIX C: QUESTIONNAIRE.....	87
APPENDIX D: STUDY AREA PICTURES.....	90
LITERATURE CITED .....	100

## LIST OF TABLES

Tables	Page
1. Study area sites and the availability of windows versus no windows as well as the number of seats available within each site.....	26
2. Descriptive statistics for the different treatment groups <sup>z, y, x, w</sup> , the total number of observations taken in each group, the total number of people observed in activities in each area, and the percent of people performing different activities in the different areas in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.....	36
3. Analysis of variance comparison of overall activity space use <sup>z</sup> in university study areas in a comparison between areas with no plants/no windows, no plants/windows, plants/no windows, and plants/windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....	39
4. Post hoc (LSD) test indicating differences in mean number of observations of people sitting in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and stress levels. ....	40
5. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total physical activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....	41
6. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total social interaction activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....	42
7. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the “no communication” activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....	43

8. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total communication activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....44
9. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total engagement activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....44
10. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total other activity score<sup>z</sup> in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....45
11. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university second floor small area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....46
12. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university fourth floor area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....47
13. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university sixth floor area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....47
14. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university north side of seventh floor area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....48
15. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university south side of seventh floor area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....49
16. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university seventh floor private area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....50

17. Analysis of variance comparison of overall activity space use <sup>z</sup> in the university first floor area in the business building in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....	51
18. Analysis of variance comparison of overall activity space use <sup>z</sup> in the university fourth floor area in the business building in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....	52
19. Analysis of variance comparison of overall activity space use <sup>z</sup> in the university second floor large area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels .....	53
20. Descriptive statistics comparison of the sitting, total physical score, and total communication score activities in the university second floor large area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels .....	54
21. Analysis of variance comparison of different activities performed in different study areas and their answers <sup>z</sup> to statements describing the types of activity in which they were involved and their reason for being in locations based on if there were no plants/no window, plants/no windows, no plants/windows, or plants/windows present, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.....	55
22. Descriptive statistics for the treatment group no plants/no windows analyzing the total number of categories of answers to the question “Why did you choose to study in this location?” <sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....	55
23. Descriptive statistics for the treatment group plants/no windows analyzing the total number of categories of answers to the question “Why did you choose to study in this location?” <sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....	56
24. Descriptive statistics for the treatment group no plants/windows analyzing the total number of categories of answers to the question “Why did you choose to study in this location?” <sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....	57

25. Descriptive statistics for the treatment group plants/windows analyzing the total number of categories of answers to the question “Why did you choose to study in this location?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.....57
26. Analysis of variance comparison of reasons<sup>z</sup> for being in each of the nine study areas and tasks performed the nine study areas that either had plants or no plants testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels .....59
27. Descriptive statistics for the treatment group second floor small area in the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....59
28. Descriptive statistics for the treatment group second floor large area in the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.. ....60
29. Descriptive statistics for the treatment group fourth floor in the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....61
30. Descriptive statistics for the treatment group sixth floor in the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....61
31. Descriptive statistics for the treatment group seventh floor north side of the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....62
32. Descriptive statistics for the treatment group seventh floor south side of the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....62

33. Descriptive statistics for the treatment group first floor of the business building analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....63

34. Descriptive statistics for the treatment group fourth floor of the business building analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels. ....64

35. Analysis of variance comparisons of quality of life mean score responses in study areas from those with no plants/no windows, no plants, windows, plants/no windows, and plant/windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....66

36. Analysis of variance comparison of quality of life mean score responses in nine study areas that had plants or no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....67

37. Analysis of variance comparison of individual stress test statements and overall stress test scores<sup>z</sup> in study areas of respondents answering<sup>y</sup> in areas with no plants/no windows, no plants/windows, plants/no windows, and plant/windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....69

38. Analysis of variance comparison of perceived stress level mean score responses in study areas from those that had plants or no plants testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....70

39. Analysis of variance comparison of different demographic backgrounds and their answers to statements describing the types of activity in which they are involved and their reason for being in locations as well as with no plants no windows, no plants and windows, plants and no windows, and plant and windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels. ....74

## **ABSTRACT**

# **THE EFFECTS OF LIVE PLANTS AND WINDOWS ON PEOPLES' USE OF INTERIOR STUDY SPACES AND THEIR PERCEIVED QUALITY OF LIFE AND STRESS LEVELS**

by

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The main objective of this study was to examine the effects of live plants and windows in interior spaces on space usage and stress levels of users. Sites were selected based on their accessibility to the general population, their expanse of space in that multiple students, faculty, and staff could use the space at once, and their general use, meaning that no other resources were available besides seating and tables, such as computers and/or access to food/drink sales. Multiple campus sites were used including those at the university library, and areas of the business building. Assortments of interior plants were included in the study based on their aesthetic features, durability, and light and water requirements. Plants were rotated in and out of the study sites on a two-week schedule. Observations were taken approximately weekly to tally where students were active in each of the study areas and the type of activities in which they were

participating. Observations occurred during high traffic times based on catalog course scheduling. Stress and quality of life measuring questionnaires were administered every week to students that were active in test sites. It was found that people were more willing to take questionnaires in areas with windows. Results demonstrate that perceived quality of life and perceived stress levels were not affected based on study environments. The study also shows that students were more prone to sit in areas that had windows, as well as communicate more in areas that had windows. There were no differences in demographic comparisons, which indicated that people were equally drawn to study areas regardless of demographic differences, and no group was more positively or negatively affected by the study environments based on windows or plants present. When each of the individual sites were looked at, no differences were found in the way in which participants answered quality of life or stress level questions based on if there were plants or no plants present in the study areas.

## CHAPTER I

### INTRODUCTION

There is a special connection between people and plants, as well as people and nature. This innate closeness to plants is thought to have developed from humans' evolution as a part of nature (Simons and Straus, 1998). As far back as ancient Egypt, physicians used natural environments as a means to improve patient health (Simons and Straus, 1998). Even then, people knew that humans shared a close tie to nature, and if used properly, there could be great healing effects.

Recent research has examined some of the effects plants have on people (Doxey et al., 2009). In a study concerning students' perception of their classroom environment and instructors, it was found that when plants were placed in the room, the students viewed the instructors more favorably when compared to instructors and courses offered in rooms where no plants had been placed. However, students' grades did not appear to be affected by the plants in the room (Doxey et al., 2009).

In a study of overall job satisfaction, people who had both plants and windows in their offices viewed their overall job satisfaction more positively when compared to those who had just windows nor no windows or plants. It was also found that plants were suitable alternatives to windows and that people with neither a plant nor a window sometimes viewed their jobs and lives as being miserable (Dravigne et al., 2008).

People can interact with plants passively and/or actively (Zampini, 1994). Passive interaction includes activities in which people are surrounded by nature/plants, but are not actively participating with it. Passive interaction includes activities such as taking a walk in a park, looking out windows at views of nature or having a plant sit on one's desk (Zampini, 1994). Active interaction involves a person actively participating with nature, such as when someone is working in a garden, creating a floral design, or pruning a tree (Zampini, 1994).

Many people feel that both active and passive interaction with plants and nature is restorative to the human spirit (Fisher, 1990; Lewis, 1979, 1996). Anyone who has marveled at the perfect flower, taken pride in growing the perfect plant, or felt excitingly renewed upon discovering the first blooms of spring has experienced the benefits of plants (Simons and Straus, 1998).

It has been found that people prefer certain types of interior environments. Investigations have found that people prefer rooms in which windows allow natural light (Think, 2003). Rooms that are painted in cool colors have been found to be more restful and spacious (Yildirim and Hidayetoglu, 2011). A study of college students found that students prefer comfortable seating arranged in a manner that promotes social interaction, as well as views of outdoor areas (Douglas and Gifford, 2001). It has been found that when college students prefer interior designs of building, such as lighting, chair arrangement, and available space, on a college campus they are more likely to spend more time on campus (Weirs-Jenssen et al., 2002).

With the steady increase in working hours by employees in the United States, research found that stress also steadily increased in workers (Schor, 1991). One study

found that 30% of adults claimed to have high stress nearly every day (Schor, 1991). Stress has effects such as loss of appetite, irritation, fatigue, and an increase in alcohol consumption, and substance abuse (Symptoms of stress.com, 2011).

The impact of nature and plants on behavior and attitudes in both indoor and outdoor settings is a question of expanding interest (Shoemaker et al., 1992).

#### *Problem statement*

The main purpose of this study was to examine building space usage and people's perceptions of quality of life and perceived stress while in study environments that had plants or no plants present and windows or no windows present.

#### *Hypothesis*

Because people are innately drawn to nature and natural surroundings, it was the hypothesis of this study that when plants were placed in a study environment, people would be drawn to sit near them, as well as feel less stress and have a more positive outlook on their overall quality of life when in these areas.

The main objectives of the study were:

1. To determine the number of people involved in activities within various study environments that included only windows, windows and plants, just plants, and no windows nor plants.
2. To measure and compare the types of activities in which people were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

3. To determine and compare perceptions of quality of life of people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
4. To determine and compare reported stress levels in people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
5. To make comparisons of the types of activities, perceptions of quality of life and stress levels amongst study participants in different study areas based on the demographics of the participants.

#### *Definition of Terms*

Anxiety: A vague unpleasant emotion that is experienced in anticipation of some misfortune (Miller, 2009).

Atrium: The central area in a building; open to the sky (Miller, 2009).

Biophilia: A hypothetical human tendency to interact or be closely associated with other forms of life in nature (Biophilia, 2011).

Horticulture therapy: The practice of horticulture as therapy to improve human well-being (Simons and Straus, 1998).

Houseplant: A plant grown or kept indoors (Houseplant, 2003).

Interiorscape: The installation of plants and other features in enclosed spaces that are not subject to outdoor weather (Pennsylvania Landscape and Nursery Association, 2007).

Green space: Any piece of land covered with vegetation. Usually refers to parks, golf courses, sports fields and other open land within the built-up area, whether publicly accessible or not (State University of New York at New Paltz, 2010).

Quality of life: Personal satisfaction or dissatisfaction with the cultural or intellectual conditions under which a person lives as distinct from material comfort (Miller, 2009).

Sociohorticulture: The theory that people and plants have an innate connection to each other (Novak, 2010).

Stress: Difficulty that causes worry or tension (Miller, 2009).

Study area: An area reserved for study (Farlex Inc., 2010).

### *Limitations*

1. Because of time limitations, this study was conducted during the course of one full school semester and two summer semesters.
2. Due to limitations of space and environmental conditions present within study areas, only a certain number and types of plants were used.
3. The subjects were those that utilized the study areas in the McCoy School of Business and the Alkek Library during the research period: one full school semester and two summer semesters.
4. There were a limited number of sites on campus suited to the experiment.
5. Observations and collection of survey data occurred once every week during one full school semester and two summer semesters.
6. Study areas were limited to those where access was granted by the administration.

### *Basic Assumptions*

It was assumed that the faculty and staff that worked in the university library and the business building whom were aware of the study objectives would not discuss the study with students, faculty and/or staff.

It was assumed that building users had a choice in where they would spend time to study and/or relax.

## CHAPTER II

### REVIEW OF LITERATURE

#### *Use of Interior Plants in Homes and Buildings*

Interior plants have been prevalent in the work setting since at least the 1960's when the "office landscape," characterized by the abundant use of large, potted plants to separate workspaces, became popular in the United States (Snyder, 1995; Sundstrom, 1986). Since that time, office landscaping has undergone several changes in definitions.

Beginning in the late 1950's, the office landscape approach to office planning was developed and widely implemented in West Germany (Pile, 1976, 1977, 1978; Rogers, 1968; Snyder, 1995). The concept of office landscaping was developed by the Quickborner Team for Planning and Organization. It was their belief that the way in which an office was physically designed would determine the amount of work and productivity achieved. It was Quickborner that first developed the "open" office, an irregularly clustered workspace separated by plants with employees grouped according to their work relationship and needs, rather than by formal patterns established by the organization (Pile, 1978). With an open office, the concept of rank and status was eliminated which, in theory, allowed for employees to better perform their jobs. Research suggested this change improved employee morale, job satisfaction, work efficiency, and decreased absenteeism when compared to conventional, unplanted offices (Bjore, 1971; Conklin 1972, 1978; Duffy, 1969; Pile 1976).

With the success of office landscaping in Germany, it was not long until the concept of interiorscaping took hold in the United States. Office landscaping based on the Quickborner model began to appear in the United States in the early 1960's. It initially was received with skepticism, because it differed quite radically from predominate office designs of the time and many planners considered its rules too restrictive (Pile, 1976, 1978). Up until this time, no true study on office landscaping had ever been conducted. Most of the beneficial claims that were made were based solely on observations from management of companies that were practicing interiorscaping (Pile, 1976, 1978).

The first research experiment to determine benefits and document claims was designed in 1967 for The Dupont Company in Wilmington, Delaware (Pile, 1976, 1978). The test space occupied one floor of an office building; the remaining floors contained conventional offices. Employee reactions to the trial were generally positive. Office landscaping was praised for its improved flexibility, reduced renovation and installation cost, and increased office efficiency (Jaeger, 1969; Rodgers, 1968). In 1968, two other major studies concerning office landscaping were conducted for the Port Authority of New York and Eastman Kodak (Pile, 1976, 1978). Employees viewed office landscaping favorably in these studies as well. There were, however, several complaints about office landscaping, including loss of privacy and increased noise. Moreover, little quantitative data existed on employee morale and efficiency, which led to office landscaping losing support and few future studies conducted on the subject (Howard, 1972; Pile, 1976, 1977).

Despite loss of interest and the limitations of research studies, claims of improved worker productivity persisted (Conklin, 1972, 1978; Marchant, 1982; Scrivens, 1980;

Snyder, 1995). Recent studies showed that people in windowless offices appear to use objects found in nature, such as plants, as “window substitutes” (Dravigne et al., 2008).

### *Biophilia*

Biophilia is a hypothetical human tendency to interact or be closely associated with other forms of life in nature (Biophilia, 2011). It was hypothesized that people have biophilic responses to certain natural elements due to the fact that humans evolved in nature and that it is in humans' genetic makeup to have positive and negative responses to certain natural elements (Ulrich, 1993). From this researchers find that modern day humans might have a biological readiness to learn and respond positively to natural elements while displaying none of this positive readiness to learn about urban and modern areas (Ulrich, 1993). It has been proposed that when people encounter unthreatening natural landscapes, they respond positively in at least three ways. With the liking/approach response, humans' are naturally drawn to environments due to evolving in certain areas. In the restoration or stress recovery response, humans recover from physiological arousal and negative emotions when immersed in nature. The enhanced high-order cognitive functioning response is when a person is in a natural setting is more able to perform higher-order cognitive functions such as creative problem solving (Ulrich, 1993). It has been hypothesized that humans' respond in these ways due to a primal instinct in which we associate these natural settings with food, water, and security (Ulrich, 1993).

Because much of human evolution took place in savanna like-settings, modern day humans now show a genetic predisposition to be drawn to natural settings that are more open, with scattered trees and relatively uniform heights of grass/groundcover

(Ulrich, 1993). Also, because water is such an important part of human life, many ancient villages were placed close to a water source. This can explain why modern day humans have a strong preference for scenes with water (Ulrich, 1993). By contrast, natural elements that have been found in research to be associated with low preference among viewers include forest settings that have closely spaced trees and elements that hinder free movement and impair vision, such as dense forests or rough ground terrain (Ulrich, 1993).

In one study that investigated different ethnicities' views on parks and the trees within parks in the United Kingdom, it was found that Asian people had more negative feelings towards parks at night, due to the fact that they associated them with crime when compared to Caucasian British people. However, Asian people had more of an affinity and spiritual connection with trees (Delavari-Edalta and Abdi, 2010). This study showed that people of different ethnic backgrounds sometimes view nature somewhat differently (Delavari-Edalta and Abdi, 2010).

#### *Interior Environmental Preferences*

Investigators have found that college students prefer certain architectural elements in interior environments to others. Research found that certain environments can stimulate social interaction and encourage students to spend more time on campus (Weirs-Jenssen et al., 2002). In a report put out by the University of San Francisco, it was suggested that environmental conditions such as lighting, acoustics, ventilation, and ergonomics all contributed to students and faculty satisfaction. It was also found that windows that allow for natural light are viewed as being important (Think, 2003).

In another study related to interior preferences in students, it was found that students preferred comfortable seating arranged so that interaction amongst them was promoted, as well as views of outdoor areas (Douglas and Gifford, 2001). In an investigation dealing with people's preferences in day rooms and lounges, it was found that chairs arranged side-by-side reduced social interaction amongst people. This was found to be especially true when the chairs were aligned along walls. Heavy, immobile furniture also reduced social interaction (Ulrich, 1991).

Another study found that building design could be a cause of stress (Ulrich, 1991). Research found that health facilities often emphasized functional effectiveness while ignoring the fact that the building's design could be psychologically "hard" on the patients. These items include elements that are imposed on patients without the possibility of personal choice, such as wall art mounted in a patient's direct line of view (Ulrich, 1991). The settings often led to anxiety, delirium, elevated blood pressure, and increased intake of pain medication (Ulrich, 1984, 1991; Wilson, 1972).

On the other hand, small changes in an interior environment can often make positive impacts. By changing the lights in a building to full spectrum fluorescent lamps and introducing plants into the classroom, Fjeld found that health complaints such as headaches and dry throats were less prevalent amongst students in high school. Students rated these rooms as being brighter and more comfortable as well (Fjeld, 2000).

Another investigation dealing with daylight and student performance gathered information from elementary schools on the amount of light in classrooms and the correlation with academic performance. The study looked at test scores in second through fifth graders in three different states. It was found that students in classrooms that had the

most sunlight progressed faster in math and reading when compared to those that had less light. Also, it was found that students that were in classrooms that had larger windows progressed faster in math and reading when compared to those that had smaller windows (Heschong Mahone Group, 1999).

Research found that color in interior environments could impact perceptions and behavior amongst people by causing varying levels of arousal and stimulation (Read and Upington, 2009). In a study dealing with color preferences in adults, participant's viewed images of two living rooms. In each image the only difference was the color palette. It was found that the living room with warm colors produced stronger responses in arousal, stimulation, and excitement. However, when participants viewed images of the living room painted with cool colors, participants were less aroused, but also viewed the room as being more spacious and restful (Yildirim and Hidayetoglu, 2011). Age should also be taken into account when adding colors to interior spaces. It has been found that people's colors preferences change over time (Read and Upington, 2009). Studies have found that young children prefer the colors blue, yellow, and red and that these colors are linked positively to their emotions (Read and Upington, 2009).

#### *Use of Plants in Prison*

With the realization that 95% of all inmates incarcerated will one day be returned to society, increasing emphasis is being placed on rehabilitating prison inmates (Skolnik and Slansky, 1991; Wiley, 1986). Vocational horticulture programs help prison inmates acquire job skills that they can then use when they reenter society (Halasz, 1982; Migura et al., 1997).

One study found that a Master Gardener program conducted in prison increased self-esteem and overall life satisfaction of prisoner students (Migura et al., 1997). Another study investigating environmental characteristics on inmate health looked at such factors as concrete cells and their locations, as well as the views that prisoners could see both from within the prison as well as outside the prison. The study compared those prisoners who had views from their cells that overlooked the enclosed concrete prison yard compared to those that have views of forest and farmland. The study found that those prisoners who were able to see natural scenes had less sick calls when compared to those prisoners that had views of buildings, prison walls, or other prisoners' cells (Moore, 1982).

#### *Effects of Passive and Active Interaction with Plants*

People can interact with plants either passively or actively (Zampini, 1994). Individuals engage in active interaction when they are directly involved with the growing of plants (Lewis, 1992). Alternatively, passive interaction occurs when an individual is simply in the presence of plant material, whether it is a potted plant that sits at a desk or when they are walking in a tree-filled park (Zampini, 1994). The mere presence of plants has been found to improve life satisfaction environmentally, economically, socially, culturally, and physically (Waliczek et al., 1996; Zampini, 1994).

##### *A. Effects of passive interaction with plants*

One study measured stress through thermal feedback and examined the influence of passive interaction with a foliage plant or a life-size color photograph of the same plant as a visual focus, to determine if a reduction of stress would occur (Coleman and Mattson, 1995). It was found that 10 of the 26 participants reacted positively to the

presence of plants or plant photos, as shown by an increase in skin temperature, which indicated a reduction in stress. The reaction occurred within 4 minutes using either stimulus (Coleman and Mattson, 1995).

Another study measured the benefits of passive interaction with plants to appendectomy patients. Plants were placed in half of the patients' rooms while other patients' rooms were left without plants (Park and Mattson, 2008). Patients exposed to plants were found to need less frequent weak and moderate analgesics when compared to patients who were not exposed to plants (Park and Mattson, 2008), and reported less subjective pain. Further, it was found that when compared to the control group, the patients in rooms with plants reported to be less fatigued by the third day after surgery (Park and Mattson, 2008). The same study found that patients who had plants in their rooms viewed their rooms as being more pleasant, with 91% of patients in the rooms with plants responding that they would return willingly to their room for a future hospitalization, while only 71% of the control group said that they would return (Park and Mattson, 2008).

In a study done by Doxey (2009), the effects of live plants within college classrooms on university students were tested by placing plants in several different classrooms, some of which contained windows and some of which did not. It was found that when plants were placed in a classroom, the students tended to view the instructor as more likable as well as viewing the course as more enjoyable. It was also found that plants tended to have the biggest effect in the rooms that did not have windows (Doxey et al., 2009).

Another study found that patients in a dental office felt less stress when a mural depicting a natural scene was hung on a wall of the waiting room, in comparison to when the walls were blank (Heerwagen and Orians, 1986). Similarly, Ulrich (1981) found that slides of nature produced more positive feelings and allowed the participants to be more wakefully relaxed.

*B. Effects of active interactions with plants*

Studies investigating active interactions with plants have found similar results. For example, horticulture is often used in rehabilitation within the corrections industry (Rice and Remy, 1994). One study measured the benefits of active interactions with plants and involved placing juvenile offenders in a vocational horticulture curriculum as a form of community service and found that horticulture programs possess the potential to reduce recidivism among juvenile offenders, as seen in the Green Brigade program in San Antonio, Texas (Cammack et al., 1998).

Research has also found that horticulture programs can reduce aggressiveness of institutionalized adolescents (Cotton, 1975). Based on these observations, a study placed juvenile offenders in a curriculum based around horticulture. The offenders were administered a pretest and a posttest that measured social bonds and careers aspirations. After the 17-week program, results showed that the offenders viewed school, teachers, themselves and the overall environment in a more positive way after participating in the horticulture curriculum (McGuinn and Relf, 2001). This research indicated that this vocational horticulture curriculum may be a tool to improve social bonding of juvenile offenders, and that the tested curriculum appeared to be effective at evoking certain

changes in attitudes about personal success and individual perceptions of personal job preparedness (McGuinn and Relf, 2001).

Another study that investigated active interactions with plants involved giving elderly patients in assisted living homes plants, as well as care tips for their plants. It was found that after just four weeks, the participants viewed themselves as being happier and having more control over their own lives (Collins et al., 2008).

*Individuals' Preferences in Scenery and the Benefits that may occur*

Throughout history, people have shared a close tie to the world and nature around them (Simons and Straus, 1998). Each individual brings accumulated knowledge and history to his or her own perceptions of an environment, thereby influencing how they experience life (Simons and Straus, 1998). It was the Kaplans (1989) who first analyzed the patterns of a population to determine the factors that individuals preferred in an environment (Kaplan and Kaplan, 1989). In this study, participants looked at photographs of plants and results found that scenes of nature/vegetation were preferred significantly over scenes of buildings.

Honeyman (1992) found similar results and further found that, even in urban environments with buildings, the presence of vegetation produced greater restoration in peoples' psyches and/or less stress when compared to settings without vegetation (Honeyman, 1992). Similarly, Owen (1994) found that people who walked through a botanical garden had significantly reduced systolic blood pressure and reported improved psychological well-being. Physiological effects observed when individuals viewed nature included lowered blood pressure, reduced muscle tension, and lower skin conductance, each of which indicated lower stress levels (Owen, 1994).

A final study found that adults who participated in outdoor activities as children were more likely to feel that trees had personal meaning to them and they were twice as likely to have participated in a gardening program when compared to those adults who did not participate in the outdoors as a child (Lohr and Pearson-Mims, 2005). This shows that if children are exposed to nature at a young age they are more likely to participate in nature when adults, theoretically helping them to lower their stress when mature.

### *Impact of Plants on Perceptions of Quality of Life*

Quality of life can be defined as a person's level of personal satisfaction or dissatisfaction with the cultural or intellectual conditions under which he/she lives. This is distinct from material comfort (Millxer, 2009).

#### *A. Studies on Perceived Quality of Life and Vegetation*

In McFarland's et al. (2008) study investigating students' perceptions of quality of life, research found that those students that used campus green spaces more frequently rated their university quality of life higher when compared to those who used green spaces on campus less frequently (McFarland et al., 2008).

A study centered on the benefits of community gardens on quality of life, found that people who worked in community gardens tended to have perceptions of a higher quality of life especially in those aspects dealing with esteem, socialization, and self-actualization, or the realization of ones' full talents and potentialities (Maslow, 1970; Waliczek et al., 1996).

Older adults, too, follow this trend of better perceptions of quality of life as well. In a study conducted to test the overall life satisfaction in people over the age of fifty, it

was found that those who participated in gardening were happier when compared to those that did not (Sommerfeld et al., 2010).

Another investigation focused on gardening activities and people's quality of life and used the Life Satisfaction Inventory A (LSIA) to test perceptions of life satisfaction in gardeners versus non-gardeners. It was found that gardeners rated their quality of life more positively on all variables as well as rated their overall health and physical activity levels higher when compared to non-gardeners (Waliczek et al., 2005).

### *Effects of Plants in School*

An overload of information, excessive stimulants and a lack of tranquility can cause continual distraction and shortened attention spans in junior high school students (Han, 2009). Since students must focus much of their attention on studying, assignments, and examinations, they are highly vulnerable to mental fatigue, which can be defined as the exhaustion of the attention span (Han, 2009; Kaplan and Kaplan, 1989). Studies have shown that college students, after taking an exam, display a reduced capacity for attention and an increase in mental fatigue (Tennessen and Cimprich, 1995). Because of this mental fatigue on students, an ideal learning environment should promote attention focusing, reduce mental fatigue and psychological stress, and encourage better learning (Han, 2009). If natural elements can reduce the amount of mental stress, then vegetation in a student learning environment, in theory, will decrease negative emotion, increase positive feelings, relieve physical stress, enhance attention, and even improve learning and examination scores (Han, 2009).

This theory has been supported by research investigating students psychological, physiological, and behavior in classrooms. It was found that when plants were introduced

into the back of classrooms, students had immediate and significantly stronger feelings of preference for the classroom, comfort, and friendliness toward others, as compared to the control group that had no plants present (Han, 2009).

One study looked at Attention Deficit Disorder (ADD) in children. The participants were exposed to natural settings in a leisurely manner and observed. Their parents were also asked to take questionnaires on how well their children focused after being exposed to different settings. It was found that children were able to focus more after being exposed to green settings (Taylor et al., 2001).

Doxey et al. (2009) found that placing plants in a college classroom caused the students to view the professor as more likeable as well as the class as more enjoyable. This was found to be especially true in classrooms that had no windows and had plants placed in them (Doxey et al., 2009).

#### *College Students Study Habits*

The knowledge that researchers possess about students' study time and its correlation to academic achievement is limited at best (Stinebrickner et al., 2004). It is thought that today's college students are spending less time studying and devoting more time to other activities such as working or watching television (Nonis et al., 2006).

Some studies have found that an increase in study time results in an increase in course grade and GPA. A one-letter grade increase in quarterly GPA was associated with a forty-hour increase in weekly studying (Lahmers et al., 2000). However, research also found that those students who had more free time to study compared to those students that had less free time to study had a significantly lower GPAs (Ackerman et al., 2003). Furthermore, many studies did not account for other study habits, such as being on time

to class, reading notes before class and, paying attention, and taking good notes during lecture (Nonis et al., 2010).

One study conducted to test these variables found that time spent studying had an influence on the performance of a student, but that this influence was moderated by other study habits that were used by the student (Nonis et al., 2010). This study also found that study time was positively related to students' grade in relation to how well a student could concentrate while they studied (Nonis et al., 2010).

### *Effects of Stress on People*

Stress is defined as the process by which an individual responds psychologically, physiologically, and often behaviorally, to a situation that challenges or threatens well-being (Baum et al., 1985).

Stressors are those things that threaten a major goal, including the maintenance of one's physical integrity as well as one's psychological well-being (Lazarus and Folkman, 1984). Research has shown that there are powerful effects on humans when they are exposed to stressors (Kemeny, 2003). Though the body is able to recover from temporary stressors, when people are exposed to prolonged stress, adverse reactions to their health can occur in a number of ways. These include damage to the autonomic nervous system, the immune system and hypothalamic-pituitary-adrenal axis, which can result in memory loss due to atrophy in the brain, and upper respiratory infections to those exposed to viruses (Kemeny, 2003).

#### *A. Sources of stress and measuring stress in college students*

Stress is common in many college students as they attempt to adapt to new encounters while in school (Ong and Cheong, 2009). In a study conducted by Ong and

Cheong (2009), students in an American degree transfer plan were administered open-ended questionnaires to determine what the leading causes of stress were in these college students. The study found that students listed five main stressors as their main causes of stress including academic workload, too many tests, difficult courses, exam grades, and lecturer characteristics (Ong and Cheong, 2009).

Another investigation focused on stressors in first year college students from rural areas, many of which were from poorer communities. The participants were administered the Stress and Support Questionnaire for University Students (SASQUS). The questionnaire consisted of twenty-two sources of stress and nine sources of support as well as one question asking whether the participants felt as if they made the right choice of study/major. The study found that fear of failure was rated the highest stressor amongst the participants, followed by financial problems, failing exams, accommodation problems, and too demanding academic workloads. Participants rated their parents as being their strongest form of support (Pillay and Ngcobo, 2010).

A final study focused on stressors in medical students. Using the General Health Questionnaire (GHQ-12) and the Medical Student Stressor Questionnaire (MSSQ), participants were asked to evaluate their stress levels and stressors. Participants reported exams as being their greatest cause of stress, followed by large amount of content to be learned, lack of time to review what had been learned, getting poor grades, and the need to do well (Yusoff et al., 2009).

### *B. Impact of stress on college students*

Stress in students has been linked to chronic fatigue syndrome in college medical students (Tanaka et al., 2009). Chronic fatigue is characterized as fatigue that lasts more

than six months and cannot be lessened by ordinary rest (Tanaka et al., 2009). It has been found that those students who suffer from fatigue and lack of sleep also suffer from mental and physical health problems (Caldwell et al., 2010). Those students who suffer from higher stress levels were also more prone to using emotional-focused stress techniques as opposed to problem-focused coping styles (Tanaka et al., 2009). Problem-focused coping styles included confronting problems and planned problem solving (Bettina, 2001), while emotional-focused stress techniques include distancing oneself, self-controlling behavior, and escape-avoidance behavior (Bettina, 2001). However, individuals often use more than one technique when dealing with stress and stressors (Bettina, 2001).

Research has also found that stress can inhibit cognitive tasks such as proof reading (Glass and Singer, 1972; Hockey, 1983). In general, college-related stress has been found to be inversely related to academic performance in traditional college students (Felsten and Wilcox, 1992; Pritchard and Wilson, 2003; Russell and Petrie, 1992), with an increased effect on college freshman (Struthers et al., 2000). Research showed that the majority of students who leave college do so before their second year largely because of their inability to adequately cope with academic stressors such as academic work load, exam grades, and difficult courses, as well as social stressors such as being away from home for the first time in the college environment (Ong and Cheong, 2009; Tinto, 1993).

With so much of the world now urbanized, people are spending 80% of their time or more inside (Fjeld et al., 1998). Since so many people spend a majority of their time indoors, it is now more important than ever to consider building design, as well as

interiorscaping and the importance of these elements on the use of areas and on perceptions of stress and quality of life.

## CHAPTER III

### METHODOLOGY

The purpose of this study was to examine building space usage and people's perception of quality of life and perceived stress while in study environments that had plants or no plants present.

The main objectives of this study were:

- 1 To determine the number of people involved in activities within various study environments that included only windows, windows and plants, just plants, and no windows nor plants.
2. To measure and compare the types of activities in which people were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
- 3 To determine and compare perceptions of quality of life of people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
4. To determine and compare reported stress levels in people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

5. To make comparisons of the types of activities, perceptions of quality of life and stress levels amongst study participants in different study areas based on the demographics of the participants.

### *Test Sites*

Sites were selected based on their accessibility to the general population, their expanse of space in that multiple students, faculty, and staff could use the space at once, and their general use, meaning that no other resources were available other than seating and tables, such as computers and/or access to food/drink sales

The study was conducted at Texas State University-San Marcos, Texas. Multiple campus sites were used including the study areas on the second floor, fourth floor, sixth floor, and seventh floors of the university library, and the study areas on the first and fourth floors of the business building (Table 1).

The interior of the library is very open with high ceilings. Windows run along the north and south facing walls on all floors with views overlooking the campus and the surrounding city and hill country of San Marcos. The second floor of the university library is used primarily as a place for students to study. Along its northern facing wall, a separate study area consists of only tables and chairs. Depending on where a person sits in the room, one may view the outdoors from windows or not. Separate from this space, but still adjacent to it, another study area offers a more relaxed setting with armchairs, coffee tables and rugs (Table 1). On the fourth floor of the university library is an area that has armchairs and coffee tables in the center of the room. From this position, students or other users cannot see out the windows (Table 1). On the library's sixth floor, there are long tables with chairs adjacent to windows that allow scenic views of campus

and natural light in seating areas (Table 1). On the seventh floor of the library, there are long rows of tables with chairs on the south side that allow no views of the outside and are lit by only artificial light. There are also four private study rooms. In each private study room, there is a single table with chairs and dry erase boards. There are windows that look out into the interior of the library, but none that give any natural light or views of outside areas. On the north side of the seventh floor, there are long rows of tables and chairs located adjacent to the windows that provide a view that overlooks the campus (Table 1).

The McCoy Business Building, built in 2006, is a relatively new building on the campus. The interior is modern and offers high ceilings. The lounge area on the first floor of the McCoy Business Building is situated along the south wall and consists of sets of four brown to black leather armchairs facing brightly colored coffee tables. The windows are distant from most of the seating, though a few seats receive some amount of natural light. Modern paintings hang above the seating areas on the walls. The study area on the fourth floor of the McCoy Business Building is a large open internal room with tables and chairs scattered throughout. There is one large window that looks out into the hallways, but does not offer a view of the outdoors (Table 1).

**Table 1. Study area sites and the availability of windows versus no windows as well as the number of seats available within each site.**

Site	Windows	No Windows	Seats available (N)
<b>Library</b>			
Second floor small area	X		29
Fourth floor		X	24

Table 1-Continued

Site	Windows	No Windows	Seats available (N)
Sixth floor		X	32
Seventh floor south side		X	26
Seventh floor north side	X		48
Seventh floor private area		X	24
<b>Business building</b>			
First floor	X		36
Fourth floor		X	50

### Plants

An assortment of interior plants were used in the study based on their aesthetic features, durability, and light and water requirements. Plants were rotated in and out of the study site on a two-week schedule. Foliage plants such as *Aglaonema pseudobracteatum* (Chinese evergreen), *Sansevieria trifasciata* (Mother-in-law's tongue), *Epipremnum aureum* (Pothos ivy), *Syngonium podophyllum* (Nephthytis), *Schefflera arboricola* (Umbrella plant), *Dracaena marginata* (Madagascar dragon tree), and *Dracaena fragrans* (Corn plant) were used in the study. These plants were strategically placed around the second, fourth, sixth, and seventh floors of the Alkek Library study areas and also on the first and fourth floors of the McCoy Business Building. Focus was towards placing the plants in high visibility and high traffic areas.

Several of the larger plants, such as the *Dracaena fragrans* (Corn plant) and the *Schefflera arboricola* (Umbrella plant), were placed on the floor near tables and windows, but so as to not interfere with space usage or traffic. Also, several of the smaller plants such as the *Sansevieria trifasciata* (Mother-in-law's tongue), and the *Epipremnum aureum* (Pothos ivy) were placed on top of the tables.

The researcher maintained plants weekly. This included watering, replacing plants that were stressed and rotating the plants based on health, vigor, and timing for the study.

### *Population*

The sample that was used in this study came from Texas State University-San Marcos, and included students, faculty, and staff that were in the process of using the test sites at the time of observation and evaluation. Participants within study areas were tallied approximately every week at various times of the day. Any person studying in areas were asked to participate in responding to the questionnaire in order to maximize response rates.

### *Treatment Versus Control Group Study Tally Areas*

At the beginning of the study, an observation was taken of all study areas. The researcher tallied where students were sitting in each of the study areas and the type of activities in which they were participating (Appendix B). Once the initial tally was completed, plants were introduced into half of the research test sites. Observations occurred approximately every week during high traffic times based on Texas State catalog course scheduling. The plants were placed in the areas, and a week later an observation were made. Two weeks after plants were introduced, another observation was made and the plants were rotated into a different study site location. With this rotation schedule, the plants were not placed in the same location twice during the nineteen-week study.

The tally sheet (Appendix B) was based on a model used in past research and had reported a reliability of 0.85 (Cooper-Marcus, 2007). The activities were broken into five separate sections to enable the observer to easily account for the activities in which

individuals were participating while in the test sites. The five main sections included physical activities, social activities, communication activities, engagement activities, and other activities. Under each of these main sections were lists of activities in which a person could be engaged, such as sitting, group work, talking on phone, looking at plants, and listening to music. Boxes under each of the actions allowed for the researcher to easily tally observations of what each person was doing in the study area. In addition to the activities listed on the tally sheet, there were also areas for the date, site location, whether there were plants and windows in the area, and the time in which observations were taken.

#### *Quality of Life Questionnaire*

The quality of life survey consisted of two questions, “When all things in your life are considered, how do you feel today?” For the first questions participants were given the choice between five different answers which they chose from a Likert- type scale (Likert, 1967), and included: “very happy,” “content,” “ok,” “not very happy,” and “miserable.” and, “Overall how would you rank your quality of life?” Possible answer choices for the second question included: “very satisfied,” “mostly satisfied,” “satisfied,” “mostly dissatisfied,” and “dissatisfied.” The survey was modified from those used in previous research, and had a reported reliability of 0.91 (Appendix C) (McFarland et al., 2008).

#### *Stress Questionnaire*

The stress questionnaire consisted of ten statements and was a modified version of the Perceived Stress Scale which had a reported reliability of 0.85 (Cohen et al., 1983). Questions dealt with how comfortable or nervous the person was feeling at the moment.

The answers were arranged on a Likert-type scale (Likert, 1967) with “1” referring to the answer “not at all” and “4” being the response of “very much so.” Examples of statements included, “I am upset about something that has occurred unexpectedly,” and “I feel that I am unable to control important things in my life” (Appendix C).

### *Demographic Section*

Students, faculty, and staff were asked to provide the following demographic information: classification/grade, age, ethnicity, gender, marital status, and whether they commute to Texas State or not. There were also two open-ended questions asking each participant about what they were working on while being in the area and why they chose to be in that particular area (Appendix C).

### *Data Analysis*

Quantitative data were entered and scored in Microsoft Excel™ (Microsoft™ Redmond WA, 2003) and then analyzed using PASW™ 18.0 (SPSS™, Inc. Chicago IL, 2009). Data were tallied as themes developed for answers given to open-ended questions. A Cronbach’s alpha test was run for the overall instrument and reported a reliability of ( $\alpha = 0.77$ ), which is a suitable level of reliability (Gall et al., 2006). The data were then analyzed using descriptive statistics, frequencies, and analysis of variance tests to see if respondents differed in the number of people participating in activities in each space, the type of activities in which people were engaged and their perceptions of quality of life and in their stress levels. Demographic comparisons were also made to observe differences between groups.

## CHAPTER IV

### RESULTS

The main purpose of this research was to investigate the impact of interior houseplants in university study areas on space usage and people's perceptions of quality of life and their own levels of stress. Descriptive statistics and comparative data analyses are contained in this chapter including the results of researcher observations and questionnaires that were taken by students, faculty, and staff in study areas in two university buildings: the main campus library and the business building.

The specific objectives of this study were:

1. To determine the number of people involved in activities within various study environments that included only windows, windows and plants, just plants, and no windows nor plants.
2. To measure and compare the types of activities in which people were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

3. To determine and compare perceptions of quality of life of people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
4. To determine and compare reported stress levels in people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
5. To make comparisons of the types of activities, perceptions of quality of life and stress levels amongst study participants in different study areas based on the demographics of the participants.

#### *Findings Related to Objective 1*

The first objective of the study was to determine the number of people involved in activities within various study environments that included only windows, windows and plants, just plants, and no windows nor plants.

Multiple campus sites were observed during the study including the study areas on the second floor, fourth floor, sixth floor, and seventh floors of the university library, and the study areas on the first and fourth floors of the business building. Plants were rotated throughout each of the study areas so that at some point in the study, each area had plants, or no plants present. The researcher took observations of activities that occurred in all nine sites for a cumulative total of 322 times.

The researcher spent between five to ten minutes in each site tallying activities in which students, faculty, and staff were engaged and attempted to remain unnoticed so as to not disturb people in the study areas. Observations were taken using tally sheets (Appendix B). Cronbach's alpha reliability of the instrument was determined for the

study to be ( $\alpha = 0.64$ ) which is a suitable level (Gall et al., 2006). Data were then transferred to Microsoft Excel™ (Microsoft™ Redmond WA, 2003) where total number of students in the areas participating in each of the individual activities and the overall scores in the areas of “physical,” “social,” “communication,” “engagement,” and “other” activities were summed.

Examples of “physical activities” in which students could be involved included sitting, reading, sleeping, and writing. “Social interaction activities” included such tasks as group work, in which a group consisted of three or more people, staff interaction, and one-on-one interaction. “Communication activities” included such things as talking on the phone, talking with students, or not communicating. Activities in the “engagement” section included such things as looking at the plants, touching the plants, and looking out windows. Activities listed under the “other” section included listening to music, and eating.

The data were scored in Microsoft Excel™ (Microsoft™ Redmond WA, 2003) when necessary then entered into PASW™ (SPSS™, Inc. Chicago IL, 2009) where descriptive and frequency tests were used to determine total number of students, faculty, and staff participating in types and categories of activities in each study area where plants or no plants were present and/or windows or no windows were present. The data were not equally stratified among study treatment areas due to the fact that the numbers of observations varied in sites. Percents of activities were calculated by dividing the number of occurrences by the number of observations in each of the four types of sites (no plants/no windows, plants/no windows, no plants/windows, plants/windows) (Table 2).

It was found that the greatest percent of people sitting in areas occurred in those that had windows. Observations found 368 people (432.90%) “sitting” in areas that had no plants/windows, while 222 people (352.38%) sat in areas that had both plants/windows. The “no plants/windows” sites were visited 85 times in total and included the second floor small area of the library, second floor large area of the library, and seventh floor north side of the library, as well as the first floor of the business building. These areas also had the greatest number of people performing the activity of “reading” (161 total; 189.41%) and writing (68 total; 80.00%). This finding was supported by past research, which has found that college students view windows that allow in natural light as important (Think, 2003).

The “plants/windows” areas were visited 63 times for observations and included the second floor small area of the library, second floor large area of the library, and the seventh floor north side of the library, as well as the first floor of the business building. It was observed that people performed the activity of “sleeping” least in these areas (4 total; 6.35%), performed “group work” more (8 total; 12.70%), worked “one-on-one” with each other more (14 total; 22.22%) and “communicated on the phone” more (18 total; 28.57%) and with other students (57 total; 90.48%,) compared to those areas that did not have windows (Table 2).

When taking out the impact of those “not communicating”, results found that people were also communicating the most in areas that had windows (Table 2). People were “not communicating” the most in areas with no plants/windows (383 total; 450.69%) (Table 2).

Sites with “no plants/no windows” were visited 81 times for observations during the study. These sites included the fourth floor, sixth floor, seventh floor south side, and the seventh floor private area of the library, as well as the fourth floor of the business building. The most common activities that occurred in these areas were people “not communicating” which was observed 77 times (95.1%), and people “working on computers” which was observed 54 times (66.67%). The no plants/no windows areas had 118 people (145.70%) performing the activity of “sitting” in these areas (Table 2).

The “plants/no windows” sites were visited a total of 93 times and included the fourth floor, sixth floor, seventh floor south side, and the seventh floor private areas of the library, as well as the fourth floor of the business building. The activity of “sitting” occurred least in these areas, which was observed 111 times (119.35%), when compared to any other area. These areas were also those where the least amount of “reading” (50 total; 53.76%) and “computer activities” were observed (53 total; 56.99%) (Table 2).

The researcher saw that the plants were viewed in a more passive way by students, faculty, and staff and were not distracting since at no time was anyone observed touching or looking at the plants in any of the study areas. This is supported by past research which found that plants introduced into classrooms were not viewed as distracting to students (Doxey et al., 2009).

**Table 2. Descriptive statistics for the different treatment groups <sup>z, y, x, w</sup>, the total number of observations taken in each group, the total number of people observed in activities in each area, and the percent of people performing different activities in the different areas in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

Dependent Variable	No Window/No Plants <sup>z</sup>			No Plants/Windows <sup>y</sup>			Plants/No Windows <sup>x</sup>			Plants/Windows <sup>w</sup>		
	Observations (N)	N	(%)	Observations (N)	N	(%)	Observations (N)	N	(%)	Observations (N)	N	(%)
<b>Physical Activities</b>												
Sitting	81	118	145.70	85	368	432.90	93	111	119.35	63	222	352.38
Standing	81	3	3.70	85	11	12.94	93	1	1.08	63	7	11.11
Sleeping	81	6	7.41	85	6	7.06	93	9	9.78	63	4	6.35
Reading	81	54	66.67	85	161	189.41	93	50	53.76	63	86	136.51
Writing	81	13	16.05	85	68	80.00	93	17	18.28	63	34	53.97
Computer Activity	81	54	66.67	85	120	141.18	93	53	56.99	63	66	104.76
Total Physical Score	81	248	306.17	85	734	863.53	93	241	259.14	63	419	665.08
<b>Social Interaction Activities</b>												
Group Activity	81	5	6.17	85	12	14.12	93	4	4.3	63	8	12.70
One-on-one Activity	81	10	12.35	85	21	24.71	93	9	9.68	63	14	22.22
Game	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00
Staff Interaction	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00

Table 2-Continued

Dependent Variable	No Window/No Plants <sup>z</sup>			No Plants/Windows <sup>y</sup>			Plants/No Windows <sup>x</sup>			Plants/Windows <sup>w</sup>		
	Observations (N)	N	(%)	Observations (N)	N	(%)	Observations (N)	N	(%)	Observations (N)	N	(%)
Total Social Interaction Score	81	15	18.52	85	33	38.82	93	13	13.98	63	22	34.92
<b>Communication Activities</b>												
On Phone	81	8	9.88	85	36	42.35	93	4	4.30	63	18	28.57
Communication with faculty/staff	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00
Communication with Student	81	37	45.68	85	78	91.76	93	32	34.40	63	57	90.48
Communication with Self	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00
Incomprehensible	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00
Communication on Computer	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00
No Communication	81	77	95.10	85	269	316.00	93	82	88.17	63	154	244.44
Total Communication Score	81	122	150.62	85	383	450.59	93	118	126.88	63	229	363.49
<b>Engagement Activities</b>												
Looking at Plants	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00
Touching Plants	81	0	0.00	85	0	0.00	93	0	0.00	63	0	0.00
Looking out Window	81	0	0.00	85	0	0.00	93	0	0.00	63	1	1.59
Engaged in Nothing	81	0	0.00	85	7	8.24	93	1	1.08	63	6	9.52

Table 2-Continued

Dependent Variable	No Window/No Plants <sup>z</sup>			No Plants/Windows <sup>y</sup>			Plants/No Windows <sup>x</sup>			Plants/Windows <sup>w</sup>		
	Observations (N)	N	(%)	Observations (N)	N	(%)	Observations (N)	N	(%)	Observations (N)	N	(%)
Total Engagement Score	81	0	0.00	85	7	8.24	93	1	1.08	63	7	11.11
<b>Other Activities</b>												
Eating	81	5	6.17	85	7	8.24	93	0	0.00	63	4	6.35
Listening to Music	81	11	13.58	85	41	48.24	93	6	6.45	63	26	41.27
Total Other Score	81	16	19.75	85	48	56.47	93	6	6.45	63	30	47.62

<sup>z</sup> No plants/no windows sites included the fourth floor, sixth floor, south side of the seventh floor, private areas on the seventh floor of the library, and fourth floor of the business building.

<sup>y</sup> No plants/windows sites included the small area on the second floor, large area on the second floor, north side of the seventh floor of the library and the first floor of the business building.

<sup>x</sup> Plants/no windows sites included the fourth floor, sixth floor, south side of the seventh floor, private areas on the seventh floor of the library, and fourth floor of the business building.

<sup>w</sup> Plants/windows sites included the small area on the second floor, large area on the second floor, north side of the seventh floor of the library and the first floor of the business building.

<sup>v</sup> Sites compared to themselves because number of observations taken for each study area was not equal.

### *Findings Related to Objective 2*

The second objective of the study was to measure and compare the types of activities in which people were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

#### *A. Overall study area comparison*

ANOVA and post hoc tests [Least Significant Difference (LSD)] were used to determine if there were statistical differences amongst the study areas on the number of people involved in different categories of activities based on if plants or windows were present (Table 3). The ANOVA test found that there were statistically significant differences in seven different areas. These included the individual activities of sitting ( $P=0.002$ ), total physical score ( $P=0.000$ ), total social interaction score ( $P=0.045$ ), no communication ( $P=0.015$ ), total communication score ( $P=0.000$ ), total the engagement score ( $P=0.014$ ), and total other score ( $P=0.000$ ).

**Table 3. Analysis of variance comparison of overall activity space use<sup>z</sup> in university study areas in a comparison between areas with no plants/no windows, no plants/windows, plants/no windows, and plant/windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable<sup>z</sup></b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
<b>Physical Activities</b>				
Sitting	3	98.11	5.01	0.002*
Reading	3	11.64	2.49	0.063
Computer activity	3	5.82	1.43	0.237

Table 3-Continued

<b>Dependent Variable<sup>z</sup></b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
Total physical score	3	711.88	11.82	0.000*
<b>Social Activities</b>				
One-on-one	3	0.62	1.76	0.172
Total social interaction score	3	1.23	2.72	0.045*
<b>Communication Activities</b>				
Communication with student	3	6.86	1.25	0.302
No communication	3	39.58	3.56	0.015*
Total communication score	3	212.41	12.44	0.000*
<b>Engagement Activities</b>				
Engaged nothing	3	0.22	3.60	0.014*
<b>Other Activities</b>				
Total other score	3	4.63	8.81	0.000*

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable in that few study participants were involved in these activities.

The post hoc analysis (LSD) for comparison of the “sitting” activity indicated that the “no plants/windows” group score was significantly different from all other study areas (Table 4). Results found that people were more likely to sit in study areas that had windows. No plants/windows areas had a mean number of 6.133 people sitting in areas when observations were taken. The lowest mean score occurred in the “plants/no windows” areas, which had a mean score of 3.00 people sitting in these areas.

**Table 4. Post hoc (LSD) test indicating differences in mean number of observations of people sitting in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and stress levels.**

<b>Sitting</b>	<b>Mean Score</b>	<b>SD</b>
No plants/no windows <sup>a</sup>	3.371	3.370

Table 4-Continued

<b>Sitting</b>	<b>Mean Score</b>	<b>SD</b>
No plants/windows <sup>b</sup>	6.133	5.562
Plants/no windows <sup>a</sup>	3.000	2.041
Plants/windows <sup>a</sup>	4.111	4.765

<sup>a, b</sup> Statistically significant values ( $P \leq 0.05$ ) are indicated by different letters.

In the total “physical activity” score (Table 5), the post hoc analysis (LSD) found that the “no plants/no windows” group score was statistically significantly different from the “no plants/windows” and the “plants/windows” score, but was significantly similar to the “plants/no windows” score. It was also found that the “plants/windows” and the “no plants/windows” score were significantly similar. These results showed that people were more prone to perform physical activities such as “sitting,” “reading,” “computer activities,” and “writing” in areas that had windows, especially in those areas that had “no plants/windows,” which had a mean score of 8.635 people completing activities in these areas when observations were conducted. The lowest mean score of 2.591 people occurred in areas that had “plants/no windows.” These results verified those found with descriptive statistics and with the previous finding of the individual “sitting” activity. The results support past research, which has found that college students place an importance on study areas that allow for natural light (Think, 2003).

**Table 5. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total physical activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Total Physical Score</b>	<b>Mean Score</b>	<b>SD</b>
No plants/no windows <sup>a</sup>	3.062	5.806

Table 5-Continued

<b>Total Physical Score</b>	<b>Mean Score</b>	<b>SD</b>
No plants/windows <sup>b</sup>	8.635	11.090
Plants/no windows <sup>a</sup>	2.591	4.399
Plants/windows <sup>b</sup>	6.651	8.363

<sup>a, b</sup> Statistically significant values ( $P \leq 0.05$ ) are indicated by different letters.

Few people were involved in social activities in observations. However the post hoc analysis (LSD) found that in the total “social interaction” activity score (Table 6), the “no plants/windows” group was statistically significantly different from all other groups. The greatest mean scores of people participating in social activities were again in areas that had windows with the highest number occurring in the “no plants/windows” area (0.388). Students, faculty, and staff were more prone to perform social activities such as “communicating with other students,” “communicating on the phone,” and “communicating with faculty/staff” when there were windows present compared to when there were no windows present.

**Table 6. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total social interaction activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Total Social Interaction Score</b>	<b>Mean Score<sup>z</sup></b>	<b>SD</b>
No plants/no windows <sup>a</sup>	0.019	0.477
No plants/windows <sup>b</sup>	0.388	0.940
Plants/no windows <sup>a</sup>	0.140	0.406
Plants/windows <sup>a</sup>	0.349	0.765

<sup>a, b</sup> Statistically significant values ( $P \leq 0.05$ ) are indicated by different letters.

<sup>2</sup> Very few observations were taken within the “total social interaction” section, which included activities such as communicating with other students, communicating on the phone, and communicating with faculty/staff.

The post hoc analysis (LSD) found that in the “no communication” activity (Table 7), the “no plants/windows” area was statistically significantly different from all other study areas. Results found that people were more likely to communicate with others in any other area besides this one. More people were involved in quiet individual activities when in this area compared to those studying in other areas.

**Table 7. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the “no communication” activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>No Communication</b>	<b>Mean Score</b>	<b>SD</b>
No plants/no windows <sup>a</sup>	2.655	2.869
No plants/windows <sup>b</sup>	4.483	4.229
Plants/no windows <sup>a</sup>	2.563	1.740
Plants/windows <sup>a</sup>	2.962	3.125

<sup>a, b</sup> Statistically significant values ( $P \leq 0.05$ ) are indicated by different letters.

In the total “communication” activity score (Table 8), the post hoc analysis test (LSD) found that the “no plants/no windows” group was similar to the “plants/no windows,” group but statistically significantly different from the “no plants/windows” group and the “plants/windows” group. It was also found that the “no plants/windows” group and the “plants/windows” group were similar. This verifies the descriptive statistics and previous ANOVA results that were found in the “no communication” activities in that the “no plants/no windows” study area was a place for students, faculty, and staff to do quiet studying and reading. However, when observing descriptive

statistics, it is clear that the “plants/windows” areas were used more for group work and one-on-one discussion. This, again, supports research that has found that plants trigger social interaction (Waliczek et al., 1996).

**Table 8. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total communication activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Total Communication Score</b>	<b>Mean Score</b>	<b>SD</b>
No plants/no windows <sup>a</sup>	1.506	2.771
No plants/windows <sup>b</sup>	4.506	5.887
Plants/no windows <sup>a</sup>	1.269	1.973
Plants/windows <sup>b</sup>	3.635	4.995

<sup>a, b</sup> Statistically significant values ( $P \leq 0.05$ ) are indicated by different letters.

The post hoc analysis (LSD) for the total “engagement” activity score (Table 9), found that the “no plants/no windows” and the “plants/no windows” group were similar while being statistically significantly different from the “no plants/windows” and “plants/windows” group, which were also similar to each other. The higher score in the “plants/windows” and “no plants/windows” group shows that people were more prone to “look at plants,” “touch plants,” or “look out windows” in these areas. However, few participated in these activities throughout all areas. This shows that plants were not distracting or annoying to people in study areas. Which also supports previous research (Doxey et al., 2009).

**Table 9. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total engagement activity score in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Total Engagement Score</b>	<b>Mean Score<sup>z</sup></b>	<b>SD</b>
No plants/no windows <sup>a</sup>	0.000	0.000
No plants/windows <sup>b</sup>	0.082	0.317
Plants/no windows <sup>a</sup>	0.011	0.104
Plants/windows <sup>b</sup>	0.111	0.406

<sup>a, b</sup> Statistically significant values ( $P \leq 0.05$ ) are indicated by different letters.

<sup>z</sup> Very few observations were taken within the “engagement” sections, which included activities such as touching the plants, looking at the plants, and looking out the windows.

In the total “other” activity score (Table 10), the post hoc analysis test (LSD) found that the “plants/no windows” group was statistically significantly different from all other groups. “Other activities” included “eating” and “listening to music.” People were most likely to eat in any of the areas except for the “plants/no windows” areas. However few observations were made of people participating in these activities in any of the observed areas.

**Table 10. Post hoc (LSD) test indicating differences in mean number of people performing activities relating to the total other activity score<sup>z</sup> in various study areas in the study of the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Total Other Score<sup>z</sup></b>	<b>Mean Score<sup>z</sup></b>	<b>SD</b>
No plants/no windows <sup>a</sup>	0.198	0.534
No plants/windows <sup>a</sup>	0.565	1.029
Plants/no windows <sup>b</sup>	0.064	0.247
Plants/windows <sup>a</sup>	0.476	0.895

<sup>a, b</sup> Statistically significant values ( $P \leq 0.05$ ) are indicated by different letters.

<sup>z</sup> Total “other activity” include eating and listening to music. Very few observations were taken within the “total other” sections.

*B. Site comparison based on plants versus no plants*

A one-way ANOVA was used to analyze each of the nine study areas to determine if there was a difference in the activities that were being conducted in each study site based on whether there were plants or no plants within the area.

No differences were found in comparisons of any of the sites in the types of activities in which people were engaged (Table 11-18), with the exception of the second floor large area in the library (Table 19). This showed that the plants appeared to have no positive nor negative effects in people's use of the areas for any types of activities in the majority of the sites.

**Table 11. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university second floor small area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
<b>Physical Activities</b>				
Sitting	1	0.56	0.15	0.703
Sleeping	1	0.00		
Reading	1	0.16	1.11	0.742
Computer activity	1	0.00	0.00	1.000
Total physical score	1	6.24	0.38	0.539
<b>Social Activities</b>				
One-on-one	1	0.00		
Total social interaction score	1	0.16	1.64	0.208
<b>Communication Activities</b>				
On phone	1	0.00		
Communication with student	1	0.33	1.00	0.423
No communication	1	0.20	0.08	0.786
Total communication score	1	0.09	0.02	0.888
<b>Engagement Activities</b>				
Engaged nothing	1	0.00		

Table 11-Continued

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
Total engagement score	1	0.01	0.05	0.829
<b>Other Activities</b>				
Listening to music	1	0.02	0.06	0.808
Total other score	1	0.78	1.73	0.197

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

**Table 12. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university fourth floor area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
<b>Physical Activities</b>				
Sitting	1	0.12	0.71	0.437
Reading	1	0.17	0.33	0.667
Total physical score	1	0.07	0.05	0.832
<b>Social Activities</b>				
One-on-one	1	0.00		
Total social interaction score	1	0.00	0.01	0.909
<b>Communication Activities</b>				
On phone	1	0.00		
Communication with student	1	0.00		
No communication	1	1.00		
Total communication score	1	0.00	0.00	0.991
<b>Engagement Activities</b>				
Total engagement score	1	0.00		
<b>Other Activities</b>				
Total other score	1	0.02	0.85	0.36

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

**Table 13. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university sixth floor area in the library in a comparison between plants and no**

plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.

Dependent Variable	df	Mean Squared	F	P
<b>Physical Activities</b>				
Sitting	1	0.01	0.01	0.945
Sleeping	1	0.00	0.00	1.000
Reading	1	0.00	0.00	1.000
Total physical score	1	0.67	0.14	0.710
<b>Social Activities</b>				
Total social interaction score	1	0.00		
<b>Communication Activities</b>				
No communication	1	1.37	0.70	0.424
Total communication score	1	0.31	0.19	0.665
<b>Engagement Activities</b>				
Total engagement score	1	0.02	0.80	0.379
<b>Other Activities</b>				
Total other score	1	0.14	2.70	0.110

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

**Table 14. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university north side of seventh floor area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

Dependent Variable	df	Mean Squared	F	P
<b>Physical Activities</b>				
Sitting	1	0.01	0.00	0.988
Reading	1	5.83	1.92	0.189
Writing	1	6.72	1.13	0.322
Computer activity	1	0.01	0.00	0.971
Total physical score	1	10.43	0.15	0.706
<b>Social Activities</b>				

Table 14-Continued

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
One-on-one	1	3.00		
Total social interaction score	1	0.45	1.01	0.321
<b>Communication Activities</b>				
With student	1	3.20	0.53	0.518
No communication	1	1.04	0.16	0.697
Total communication score	1	6.50	0.47	0.497
<b>Engagement Activities</b>				
Total engagement score	1	0.13	1.30	0.261
<b>Other Activities</b>				
Listening to music	1	0.48	1.32	0.273
Total other score	1	0.05	0.08	0.774

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

**Table 15. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university south side of seventh floor area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
<b>Physical Activities</b>				
Sitting	1	6.00	1.79	0.214
Reading	1	0.67	0.24	0.653
Writing	1	1.00	1.00	0.423
Computer activity	1	0.13	0.10	0.766
Total physical score	1	0.90	0.06	0.802
<b>Social Activities</b>				
Total social interaction score	1	0.00	0.00	0.968
<b>Communication Activities</b>				
Communication with student	1	0.50		
No communication	1	2.92	2.07	0.184
Total communication score	1	0.00	0.00	0.975
<b>Engagement Activities</b>				

Table 15-Continued

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
Total engagement score	1	0.00		
<b>Other Activities</b>				
Listening to music	1	0.00		
Total other score	1	0.00	0.00	0.953

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>2</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

**Table 16. Analysis of variance comparison of overall activity space use<sup>2</sup> in the university seventh floor private area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
<b>Physical Activities</b>				
Sitting	1	6.72	1.01	0.329
Standing	1	0.17	0.33	0.667
Reading	1	6.86	3.43	0.123
Computer activity	1	12.60	2.08	0.175
Total physical score	1	11.58	0.39	0.537
<b>Social Activities</b>				
Group	1	0.00		
One-on-one	1	0.08	0.56	0.482
Total social interaction score	1	0.20	0.40	0.532
<b>Communication Activities</b>				
On phone	1	0.00		
Communication with student	1	0.29	0.09	0.765
No communication	1	2.00	1.00	0.356
Total communication score	1	1.90	0.32	0.576
<b>Engagement Activities</b>				
Total engagement score	1	0.00		
<b>Other Activities</b>				
Total other score	1	0.87	2.36	0.134

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

**Table 17. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university first floor area in the business building in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

Dependent Variable	df	Mean Squared	F	P
<b>Physical Activities</b>				
Sitting	1	3.03	0.06	0.812
Standing	1	32.67		
Sleeping	1	0.17	1.00	0.374
Reading	1	3.33	0.52	0.482
Writing	1	0.64	0.60	0.454
Computer activity	1	0.06	0.02	0.891
Total physical score	1	4.90	0.03	0.86
<b>Social Activities</b>				
Group	1	0.19	1.43	0.286
One-on-one	1	0.01	0.01	0.921
Total social interaction score	1	0.93	0.66	0.424
<b>Communication Activities</b>				
On phone	1	0.00	0.00	1.000
Communication with student	1	2.22	0.21	0.660
No communication	1	28.63	0.90	0.353
Total communication score	1	0.21	0.00	0.986
<b>Engagement Activities</b>				
Engaged nothing	1	0.30	1.80	0.272
Total engagement score	1	0.03	0.16	0.694
<b>Other Activities</b>				
Eating	1	0.21	1.88	0.220
Listening to music	1	0.03	0.03	0.879
Total other score	1	1.51	0.70	0.410

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

**Table 18. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university fourth floor area in the business building in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
<b>Physical Activities</b>				
Sitting	1	5.55	0.48	0.495
Sleeping	1	0.00		
Reading	1	1.61	0.45	0.509
Writing	1	2.01	1.86	0.231
Computer activity	1	0.68	0.28	0.600
Total physical score	1	0.97	0.02	0.892
<b>Social Activities</b>				
One-on-one	1	0.08	0.44	0.541
Total social interaction score	1	0.05	0.19	0.665
<b>Communication Activities</b>				
On phone	1	0.00		
Communication with student	1	0.05	0.07	0.809
No communication	1	0.50	0.06	0.816
Total communication score	1	3.06	0.25	0.620
<b>Engagement Activities</b>				
Total engagement score	1	0.00		
<b>Other Activities</b>				
Listening to music	1	0.00		
Total other score	1	0.46	1.71	0.201

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

The large area on the second floor of the library consisted of a space with wooden table and chairs arranged along windows that allowed in natural light and offered views of green spaces on campus.

Results found statistical significances in comparisons of the activities of “sitting” ( $P=0.015$ ), the “total physical” score ( $P=0.029$ ) and the “total communication” score ( $P=0.026$ ) (Table 19).

**Table 19. Analysis of variance comparison of overall activity space use<sup>z</sup> in the university second floor large area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

Dependent Variable	df	Mean Squared	F	P
<b>Physical Activities</b>				
Sitting	1	153.59	6.65	0.015*
Reading	1	29.37	3.84	0.061
Writing	1	4.32	1.33	0.264
Computer activity	1	13.62	2.24	0.147
Total physical score	1	623.38	5.20	0.029*
<b>Social Activities</b>				
Group	1	0.20	0.20	0.685
One-on-one	1	0.55	2.46	0.152
Total social interaction score	1	2.13	2.06	0.160
<b>Communication Activities</b>				
On phone	1	0.08	0.47	0.511
Communication with student	1	13.21	1.67	0.221
No communication	1	42.43	3.40	0.075
Total communication score	1	130.97	5.40	0.026*
<b>Engagement Activities</b>				
Total engagement score	1	0.068	0.58	0.450
<b>Other Activities</b>				
Listening to music	1	0.19	0.58	0.450
Total other score	1	0.12	0.16	0.693

\* Statistically significant at ( $P \leq 0.05$ ).

<sup>z</sup> Some variables were not run in the ANOVA test due to lack of data for that variable.

Descriptive statistics were run to compare the statistically significant activities that were found in the ANOVA test based on whether there were plants or no plants present in the study area (Table 20).

**Table 20. Descriptive statistics comparison of the sitting, total physical score, and total communication score activities in the university second floor large area in the library in a comparison between plants and no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Second Floor Large Area Library</b>	<b>Mean Score</b>	<b>SD</b>
<b>Sitting</b>		
Plants	3.77	3.219
No plants	8.14	5.543
<b>Total physical score</b>		
Plants	7.54	6.424
No plants	16.27	12.844
<b>Total communication score</b>		
Plants	3.77	3.086
No plants	7.77	5.715

The data showed that in the second floor large area in the library, more people were prone to participate in some activities when there were no plants present. Plants, in four-inch pots, were placed on top of all the tables. This area was the largest and busiest study area in any of the test sites. People may have been less likely to perform activities in the area when the plants were present since they took up space on the tables when present and made the area seem more crowded.

In addition to observations taken within study areas by the researcher, participants were also asked to answer two open-ended questions determining what they were working on within the study area and why they chose to be in that particular area. Answerers to questions were tallied by the researcher based on the themes developed.

Frequency and ANOVA tests were run to determine if there were any statistical significant differences in the way in which participants answered these questions. It was found that there were statistical significant differences in the way in which participants answered the question, “Why did you choose to study in this location?” ( $P=0.046$ ) (Table 21).

**Table 21. Analysis of variance comparison of different activities performed in different study areas and their answers<sup>z</sup> to statements describing the types of activity in which they were involved and their reason for being in locations based on if there were no plants/no window, plants/no windows, no plants/windows, or plants/windows present, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>Df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
What are you working on while you are in this area?	3	61.26	1.77	0.152
Why did you choose to study in this location	3	140.98	2.70	0.046*

\*Statistically significant values ( $P \leq 0.05$ ).

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

Frequency tests were run to determine the different answers given for the question “Why did you choose to study in this location?” by participants in sites depending on if there were no plants/no window, plants/no windows, no plants/windows, or plants/windows (Tables 22-25).

**Table 22. Descriptive statistics for the treatment group no plants/no windows analyzing the total number of categories of answers to the question “Why did you**

choose to study in this location?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.

No plants/no windows	Frequency	Valid (%)
Quiet	10.00	50.00
Close to class	2.00	10.00
Concentrate	1.00	5.00
Nice environment	3.00	15.00
Convenience	1.00	5.00
Study	2.00	10.00
Waiting on a friend	1.00	5.00
Total	20.00	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 23. Descriptive statistics for the treatment group plants/no windows analyzing the total number of categories of answers to the question “Why did you choose to study in this location?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

Plants/no windows	Frequency	Valid (%)
Quiet	47.00	34.80
Close to class	20.00	14.80
Concentrate	11.00	8.10
Like the view	4.00	3.00
Comfortable	5.00	3.70
Close to printer	1.00	0.70
Easy access	1.00	0.70
Nice environment	12.00	8.90
Obligated to work	2.00	1.50
Close to home	1.00	0.70
Convenience	8.00	5.90
Has table	2.00	1.50
Many reasons	1.00	0.70

Table 23-Continued

<b>Plants/no windows</b>	<b>Frequency</b>	<b>Valid (%)</b>
Lots of homework	1.00	0.70
Study group	6.00	4.40
Day off	1.00	0.70
No reason	1.00	0.70
Available space	2.00	1.50
Peaceful	2.00	1.50
Family	1.00	0.70
Waiting on friend	1.00	0.70
Grew up here	1.00	0.70
Like the school	4.00	3.00
Total	135.00	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 24. Descriptive statistics for the treatment group no plants/windows analyzing the total number of categories of answers to the question “Why did you choose to study in this location?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>No plants/no windows</b>	<b>Frequency</b>	<b>Valid (%)</b>
Quiet	34.00	77.30
Close to class	1.00	2.30
Concentrate	1.00	2.30
Close to printer	1.00	2.30
Nice environment	3.00	6.80
No reason	1.00	2.30
Study	3.00	6.80
Total	44.00	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 25. Descriptive statistics for the treatment group plants/windows analyzing the total number of categories of answers to the question “Why did you choose to**

**study in this location?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Plants/windows</b>	<b>Frequency</b>	<b>Valid (%)</b>
Quiet	27.00	32.90
Close to class	11.00	13.40
Concentrate	7.00	8.50
Like the view	2.00	2.40
Comfortable	3.00	3.70
Close to printer	1.00	1.20
Easy access	2.00	2.40
Nice environment	6.00	7.30
Obligated to work	1.00	1.20
Close to home	4.00	4.90
Convenience	4.00	4.90
Study group	2.00	2.40
Available space	2.00	2.40
Study	1.00	1.20
Family	1.00	1.20
Music Program	1.00	1.20
Waiting on friend	1.00	1.20
Like the school	2.00	2.40
Visiting friend	1.00	1.20
Like San Marcos	2.00	2.40
Business school here	1.00	1.20
Total	82.00	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

The findings show that the most diverse range of answers occurred in those areas that had plants in the study areas. Also, the only area in which people did not list the answer of “study” was in areas that had “plants/no windows.”

### *C. Site comparison based on plants versus no plants for open-ended questions*

Frequency and ANOVA tests were run to determine if there were any differences in the way that participants answered two open-ended questions dealing with what

participants were working on and why they chose to be in certain locations. Answers were tallied by the researcher and entered into categories based on responses. It was found that there were statistically significant differences in the way that participants answered the question, “What are you working on while you are in this area?” ( $P=0.031$ ) (Table 26) by individual site comparisons amongst the nine study sites included in the study and based on whether there were plant or no plants present.

**Table 26. Analysis of variance comparison of reasons<sup>z</sup> for being in each of the nine study areas and tasks performed the nine study areas that either had plants or no plants testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
What are you working on while you are in this area?	1	161.79	4.71	0.031*
Why did you choose to study in this location?	1	7.43	0.14	0.709

\* Statistically significant values ( $P \leq 0.05$ ).

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

Frequency tests were run to determine the different answers given for the question “What are you working on while you are in this area?” by participants (Tables 27-34).

**Table 27. Descriptive statistics for the treatment group second floor small area in the library analyzing the total number of categories of answers to the question**

**“What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Second Floor Small Area (Library)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	6	40.0	4	25.0
Reading	2	13.3	1	6.3
Essay/paper	1	6.7	1	6.3
Application	0	0.00	1	6.3
Art	1	6.7	1	6.3
Studying	4	26.7	3	18.8
Bachelor degree	0	0.00	1	6.3
Joining a sorority	0	0.00	2	12.5
Computer work	0	0.00	1	6.3
Relaxing	1	6.7	0	0.00
School	0	0.00	1	6.3
Total	15	100.00	16	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 28. Descriptive statistics for the treatment group second floor large area in the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Second Floor Large Area (Library)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	9	50.0	21	32.8
Reading	0	0.00	4	6.3
Essay/paper	1	5.6	3	4.7
Group work	0	0.00	4	6.3
Art	0	0.00	1	1.6
Preparing for class	0	0.00	1	1.6
Studying	6	33.3	25	39.1
Bachelor degree	1	5.6	1	1.6
Agenda	0	0.00	1	1.6
Test	0	0.00	1	1.6
School	1	5.6	1	1.6
Masters	0	0.00	1	1.6
Total	18	100.00	64	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 29. Descriptive statistics for the treatment group fourth floor in the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Fourth Floor (Library)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	1	100.00	0	0.00
Studying	0	0.00	1	100.00
Total	1	100.00	1	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 30. Descriptive statistics for the treatment group sixth floor in the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Sixth Floor (Library)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	2	28.6	2	40.0
Reading	2	28.6	1	20.0
Studying	0	0.00	1	20.0
Test	1	14.3	0	0.00
Computer work	1	14.3	0	0.00
Nothing	0	0.00	1	20.0
Audit	1	14.3	0	0.00
Total	7	100.00	5	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from

responses to the open-ended questions.

**Table 31. Descriptive statistics for the treatment group seventh floor north side of the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Seventh Floor North Side (Library)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	5	31.3	5	21.7
Reading	2	12.5	2	8.7
Essay/paper	2	12.5	4	17.4
Studying	6	37.5	10	43.5
Getting better grades	0	0.00	1	4.3
Quiz	0	0.00	1	4.3
Computer work	1	6.3	0	0.00
Total	16	100.00	23	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 32. Descriptive statistics for the treatment group seventh floor south side of the library analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Seventh Floor South Side (Library)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	1	14.3	0	0.00
Reading	1	14.3	1	25.0
Essay/paper	2	28.6	0	0.00
Application	0	0.00	1	25.0

Table 32-Continued

<b>Seventh Floor South Side (Library)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Studying	3	42.9	2	50.0
Total	7	100.00	4	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

No data was run for the seventh floor private areas in the library due to the fact that questionnaires were not administered in these areas so as to not disturb students, faculty, and staff that were working privately.

**Table 33. Descriptive statistics for the treatment group first floor of the business building analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>First Floor (Business Building)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	4	11.1	11	31.4
Reading	1	2.8	3	8.6
Essay/paper	1	2.8	1	2.9
Application	1	2.8	0	0.00
Group work	3	8.3	0	0.00
Questionnaire	1	2.8	1	2.9
Preparing for class	1	2.8	1	2.9
Studying	4	11.1	14	40.0
Waiting on class	1	2.8	0	0.00
Bachelor degree	3	8.3	3	8.6
Computer work	2	5.6	0	0.00
Relaxing	1	2.8	0	0.00
School	9	25.0	0	0.00
Finding a career	1	2.8	0	0.00

Table 33-Continued

<b>First Floor (Business Building)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Nothing	3	8.3	0	0.00
Resume	0	0.00	1	2.9
Total	36	100.00	35	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

**Table 34. Descriptive statistics for the treatment group fourth floor of the business building analyzing the total number of categories of answers to the question “What are you working on while you are in this area?”<sup>z</sup> in the study of the effects of live plants and windows on the use of interior study space, perceived quality of life and measured stress levels.**

<b>Fourth Floor (Business Building)</b>	<b>Frequency Plants</b>	<b>Valid (%) Plants</b>	<b>Frequency No Plants</b>	<b>Valid (%) No Plants</b>
Homework	8	28.6	7	50.0
Essay/paper	1	3.6	0	0.00
Studying	13	46.4	4	28.6
Bachelor degree	1	3.6	0	0.00
Test	3	10.7	0	0.00
School	1	3.6	2	14.3
Finding a career	0	0.00	1	7.1
Nothing	1	3.6	0	0.00
Total	28	100.00	14	100.00

<sup>z</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

The findings showed that the areas have similar numbers of people performing activities in areas that have plants and no plants with the exception of the second floor large area in the library which had many more people participating in a diversity of activities, especially when there were no plants present. These findings verify earlier findings presented in objective two.

### *Findings Related to Objective 3*

The third objective of the study was to determine and compare perceptions of quality of life of people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

Questionnaires were administered by the researcher randomly throughout the week during the spring and summer semesters between the hours of 8:00 am and 6:00 pm during times in which there was high traffic in the study areas. Participants were asked to take the questionnaire and notified that for participating they would receive the incentive of being included into a weekly drawing for a \$25 gift card to Wal-Mart. The researcher administered questionnaires on 27 different occasions throughout the spring and summer semesters and collected a total of 300 surveys. Cronbach's alpha reliability for the quality of life questions was ( $\alpha = 0.60$ ) which is a suitable level of reliability (Gall et al., 2006).

A frequency test was conducted to determine how many people in each area answered the quality of life question: "When all things in your life are considered, how do you feel today?" Participants were able to answer from the following five choices: "very happy," "content," "ok," "not very happy," and "miserable." Another question asked, "Overall, how would you rank the quality of you life?" Participants were able to choose from the following five choices: "very satisfied," "mostly satisfied," "satisfied," "mostly dissatisfied," and "dissatisfied."

Initial results found that more people were administered and agreed to take the questionnaire in areas that had windows versus those in areas that did not have windows, due to the fact that more people sat in study areas that had windows, as mentioned before in Tables 4 and 5.

A one-way ANOVA test was conducted to determine if there were any differences between responses to the quality of life questions gathered from participants replying to the survey while in the different study areas. It was found that there were no statistical significant differences in the way that the participants responded between the “no plants/no windows,” “no plants/windows,” “plants/no windows,” and “plants/windows” groups (Table 35). Students, faculty, and staff participating in the study viewed their quality of life similarly regardless of whether they were in areas with plants or windows

**Table 35. Analysis of variance comparisons of quality of life mean score responses in study areas from those with no plants/no windows, no plants/windows, plants/no windows, and plant/windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b><i>P</i></b>
When all things in your life are considered, how do you feel today? <sup>z</sup>	3	0.37	0.60	0.618
Overall, how would you rank the quality of your life? <sup>y</sup>	3	0.26	0.34	0.798

<sup>z</sup> Answers choices included “very happy,” “content,” “ok,” “not very happy,” and

“miserable.”

<sup>y</sup> Answer choices included “very satisfied,” “mostly satisfied,” “satisfied,” “mostly dissatisfied,” and “dissatisfied.”

The findings do not support data that has been found in past research, which has found that green spaces are correlated to more positive views of quality of life (McFarland et al., 2008) and that a lack of greenery can sometimes lead to poor perceptions of quality of life (Dravigne et al., 2008).

One reason that the results from the study may not correspond with past studies could be that people whom participated in the study chose the areas in which they wanted to study and could leave at any time, versus past studies in which participants studied were in allocated workspaces. Therefore, participants may have needed more time in areas that had plants and/or windows before the setting influenced their quality of life views.

*A. Site comparison based on plants versus no plants*

A one-way ANOVA was used to study responses to two quality of life questions based on whether there were plants or no plants in the nine study sites. It was found that there was no statistical significant difference in the way that people answered the two quality of life questions (Table 36).

**Table 36. Analysis of variance comparison of quality of life mean score responses in nine study areas that had plants or no plants, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
When all things in your life are considered, how do you feel today? <sup>z</sup>	1	0.01	0.02	0.878
Overall, how would you rank the quality of your life? <sup>y</sup>	1	0.28	0.37	0.541

<sup>z</sup> Answers choices included “very happy,” “content,” “ok,” “not very happy,” and “miserable.”

<sup>y</sup> Answer choices included “very satisfied,” “mostly satisfied,” “satisfied,” “mostly dissatisfied,” and “dissatisfied.”

### *Findings Related to Objective 4*

The fourth objective of the study was to determine and compare reported stress levels in people who were involved in activities in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

The stress questionnaire consisted of ten statements that were rated by respondents on a Likert scale (Likert, 1967) in which “1” corresponded with “not at all,” and “4” corresponded with “very much so.” Six of the ten statements were reverse coded so that “4” would be the most positive answer indicating the least stress, and “1” would be the least positive answer indicating the most stress. Overall scores for each question could range from 10-40 with a higher score being more positive and indicating less stress. A median score was 25.00). Three hundred responses were entered into Microsoft Excel™ (Microsoft™ Redmond WA, 2003) so that an overall score could be obtained for each respondent for all ten questions. Scores and responses were also entered into PAWS™ (SPSS™, inc. Chicago IL, 2009). Cronbach’s alpha reliability for the instrument was determined to be ( $\alpha = 0.82$ ) which is a suitable level of reliability (Gall et al., 2006).

The mean stress test score for this study was 25.40 and indicated that the participants viewed themselves as having slightly less stress than the average norm value for the instrument (Cohen et al., 1983) A one-way ANOVA compared responses to individual questions as well as on overall stress scores. It was found that there were no significant differences in the way that participants answered the individual questions when they were responding within the individual areas that had “no plants/no windows,” “no plants/windows,” “plants/no windows,” and “plants/windows” (Table 37).

Additionally, there were no statistically significant differences in overall stress test scores of those individuals participating in activities in either the “no plants/no windows,” “no plants/windows,” “plants/no windows,” and “plants/windows” areas (Table 37).

Therefore, students, faculty, and staff participating in the study viewed their stress levels similarly regardless of the setting in which they were sitting/studying and whether it contained plants or windows. This did not support past research which has found that people felt less stress when they are exposed to natural scenery (Heerwagen and Orians, 1986).

**Table 37. Analysis of variance comparison of individual stress test statements and overall stress test scores<sup>z</sup> in study areas of respondents answering<sup>y</sup> in areas with no plants/no windows, no plants/windows, plants/no windows, and plant/windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
I am upset about something that has occurred unexpectedly. <sup>x</sup>	3	0.22	0.25	0.860
I feel that I am unable to control the important things in my life. <sup>x</sup>	3	0.29	0.38	0.769
I feel nervous and stressed. <sup>x</sup>	3	0.59	0.69	0.557
I feel comfortable in my ability to handle my personal problems.	3	0.93	1.24	0.296
I feel that things are going my way.	3	0.08	0.13	0.944
I feel I can control irritations in my life.	3	2.05	2.58	0.054
I feel that I am on top of things.	3	0.88	1.34	0.260

Table 37-Continued

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
I feel angered because things are outside my control <sup>x</sup>	3	0.46	0.67	0.570
I feel that difficulties are piling up so high that I cannot overcome them. <sup>x</sup>	3	0.15	0.22	0.882
Overall Answer Score <sup>z</sup>	3	25.40	0.95	0.415

<sup>z</sup> Score ranged between 10-40 with a lower score indicating more stress and a higher score indicating less stress.

<sup>y</sup> Answer choices included “1” corresponding with “not at all,” “2” corresponding with “somewhat,” “3” corresponding with “moderately so,” and “4” corresponded with “very much so.”

<sup>x</sup> These statements were reverse coded for data analysis so that the most positive answer received the highest score.

#### *A. Site comparison based on plants versus no plants for stress test results*

A one-way ANOVA was run on the ten stress test statements based on whether there were plants or no plants in each of the study sites. It was found that there were no statistically significant differences in the way that people answered the stress test statements or on the overall stress test scores based on if there were plants or no plants in the study area (Table 38).

This does not correspond with past research, which has found that vegetation can positively affect stress level of people in urban environments with buildings when compared to when there is no vegetation (Honeyman, 1992).

**Table 38. Analysis of variance comparison of perceived stress level mean score responses in study areas from those that had plants or no plants testing the effects of**

**live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
I am upset about something that has occurred unexpectedly. <sup>x</sup>	1	0.01	0.02	0.541
I feel that I am unable to control the important things in my life. <sup>x</sup>	1	0.01	0.01	0.933
I feel nervous and stressed. <sup>x</sup>	1	0.01	0.01	0.913
I feel comfortable in my ability to handle my personal problems.	1	1.49	1.98	0.161
I feel that things are going my way.	1	0.10	0.17	0.684
I feel that I cannot cope with all the things I have to do. <sup>x</sup>	1	0.29	0.40	0.526
I feel I can control irritations in my life.	1	0.44	0.54	0.462
I feel that I am on top of things.	1	0.56	0.85	0.356
I feel angered because things are outside my control <sup>x</sup>	1	0.45	0.66	0.416
I feel that difficulties are piling up so high that I cannot overcome them. <sup>x</sup>	1	0.36	0.54	0.465
Overall Answer Score <sup>z</sup>	1	0.84	0.03	0.861

<sup>x</sup> These statements were reverse coded for data analysis so that the most positive received the highest score.

*Finding Related to Objective 5*

The fifth objective of the study was to make comparisons of the types of activities, perceptions of quality of life and stress levels of study participants in different study areas based on the demographics of the participants. Frequency tests determined the demographic breakdown of the 300 study participants including their gender, ethnicity, marital status, age, school classification, and whether the participant was a

commuter or not. According to the Texas State University–San Marcos Institutional Data Office (Texas State University, 2011), the student population consisted of 56.4% females and 43.6% males, of which 63.6% are Caucasian, 23.3% are Hispanic-American, 6.3% are African-American, 2.8% are Asian-American, 1.5% are unknown, and 0.7% are Native-American. The Texas State population included 81.8% undergraduates under the age of 25, 10.8% between the ages of 25-29, and 7.4% are 30 years of age or older. The Texas State population included 16.0% freshman, 19.5% sophomores, 20.9% juniors, 27.95 seniors, and 12.3% graduate students.

Results found that 45.3% (136) of the questionnaires were taken by males, while 54.7% (164) were taken by females. Respondents included 58.0% (174) Caucasian, 27.7% (77) Hispanic-American, 7.3% (22) other, 4.3% (13) African-American, 3.7% (11) Asian-American, and 0.3% (1) Native-American. Less than 1.00% (0.7%; 2 total) did not respond. With regards to age, it was found that 42.7% (128) of people that took the questionnaire were between the ages of 21-23, 29.0% (87) were between the ages of 18-20, 14.3% (43) were between the ages of 24-26, 8.7% (26) were 30 years of age or older, and 5.0% (15) were between the ages of 27-29 and 0.3 % (1) did not respond. Respondents included 60.3% (181) who did not commute to campus and 38.0% (114) of respondents commuted while 1.7% (5) did not respond. When looking at grade classification amongst study participants, it was found that 43.3% (130) of participants were seniors, 24.7% (74) were juniors, 13.7% (41) were sophomores, 9.7% (29) were graduate students, 8.0% (24) were freshman, 0.3% (1) were alumni and 0.3% (1) did not respond. Eighty-four percent (252) of survey participants were single, 11.7% (35) were

married, 1.7% (5) were in relationships, 1.7% (5) were divorced and 0.7% (3) did not respond.

Therefore, data show that this study included more minority students and less Caucasians than the general population of Texas State University–San Marcos. However, the study had a similar age distribution to those for Texas State University-San Marcos. The study sample was also weighted heavier towards upperclassmen compared to over Texas State University-San Marcos population.

Analysis of variance tests were conducted to compare responses of survey participants based on their demographic background on the variables of which type of study atmosphere they chose (“no plants/no windows,” “no plants/windows,” “plants/no windows,” and “plants/windows”), what type of activity in which they were involved (“What are you working on while in this area?”) and why the respondents chose to work in the location (“Why did you choose to be in this location?”). No differences were found in the types of study environments chosen, the types of activities in which respondents were involved, and the reasons why respondents chose to work in the environment (Table 39). Therefore, no other comparisons were made amongst respondents of different demographic backgrounds for quality of life statements and stress test scores and individual statements since differences discovered would not have been related to study areas. People of varied demographic backgrounds appeared to be equally drawn to any of the areas regardless of plants or windows. This is supported by past research, which found that there were no differences in the way in which people viewed job satisfaction based on demographics (Dravigne et al., 2008).

**Table 39. Analysis of variance comparison of different demographic backgrounds and their answerers to statements describing the types of activity in which they are involved and their reason for being in locations as well as with no plants no windows, no plants and windows, plants and no windows, and plant and windows, testing the effects of live plants and windows on use of interior study space and perceived quality of life and measured stress levels.**

<b>Dependent Variable</b>	<b>df</b>	<b>Mean Squared</b>	<b>F</b>	<b>P</b>
Plants/No plants and Windows/No windows <sup>z</sup>	4	0.21	0.21	0.935
What are you working on while you are in this area? <sup>y</sup>	4	22.74	0.66	0.623
Why did you choose to be in this location? <sup>y</sup>	4	57.78	1.08	0.365

\* Statistically significant values ( $P \leq 0.05$ ).

<sup>z</sup> “plants/no plants” and “windows/no windows” areas were analyzed using and ANOVA post hoc (LSD) test.

<sup>y</sup> Answers to questions were tallied by the researcher based on themes developed from responses to the open-ended questions.

## CHAPTER V

### SUMMARY, CONCLUSION, AND RECOMMENDATIONS

#### *Purpose of the Study*

The main objective of this research was to examine building space usage and people's perception of quality of life and stress while in study environments that have plants or no plants present.

Specific objectives of this study were:

1. To determine the number of people involved in activities within various study environments that included only windows, windows and plants, just plants, and no windows nor plants.
2. To measure and compare the types of activities in which people were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
3. To determine and compare perceptions of quality of life of people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.
4. To determine and compare reported stress levels in people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

5. To make comparisons of the types of activities, perceptions of quality of life and stress levels amongst study participants in different study areas based on the demographics of the participants.

#### *Objective 1*

The first objective of the study was to determine the number of people involved in activities within various study environments that included only windows, windows and plants, just plants, and no windows nor plants.

The researcher spent between five to ten minutes in each site taking tallies of activities that students, faculty, and staff were engaged in and attempted to remain unnoticed so as to not disturb people in the study areas. Observations were taken using tally sheets (Appendix B) and then transferred to Microsoft Excel™ (Microsoft™ Redmond WA, 2003) where total number of students in the areas participating in each of the individual activities and the overall scores in the areas were obtained.

The study found that the areas in which people were observed performing the most activities occurred in the “no plants/windows” areas and the areas in which people were observed performing the least activities were in the “plants/no windows” areas. It was also found that people were more prone to communicate in areas that had windows.

The findings showed that including windows into study areas on university campuses has the potential to promote students to study more in these areas, as well as to increase communication amongst students, faculty, and staff.

## *Objective 2*

The second objective of the study was to measure and compare the types of activities in which people were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

Frequency and ANOVA tests were run to compare the types of activities that students/faculty/staff were involved in within the study areas. It was found that there were significant differences in seven of the activities that could occur in the areas.

A one-way ANOVA was used to analyze each of the nine study areas to determine if there was a difference in the activities that were being conducted in each study site based on whether there were plants or no plants within the area. No differences were found in comparisons of any of the sites in the types of activities in which people were engaged, with the exception of the second floor large area in the library.

Frequency and ANOVA tests were run to determine if there were any statistical significant differences in the way in which participants answered two open-ended questions dealing with what people were doing while in the areas and why they chose to be in that particular area. The findings show that the most diverse range of answers occurred in those areas that had plants in the study areas. Also, the only area in which people did not list the answer of “study” was in areas that had “plants/no windows.”

The results show that the most activities that occurred were in areas that had windows. The most diversity in answers given for the two open-ended questions occurred in areas that had plants.

The findings show that by having windows in university study areas has the potential to promote activities within the areas. It also shows that by introducing plants

into study areas may have an effect on the type of activities in which people perform in study areas. Meaning that by introducing plants into a study area may cause people to use the study area for more diverse activities.

### *Objective 3*

The third objective of the study was to determine and compare perceptions of quality of life of people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

Participants were asked to take questionnaires, two of which dealt with quality of life. A one-way ANOVA test was conducted to determine if there were any differences between responses to the quality of life questions gathered from participants replying to the survey while in the different study areas. It was found that there were no statistical significant differences in the way that the participants responded between the “no plants/no windows,” “no plants/windows,” “plants/no windows,” and “plants/windows” groups.

A one-way ANOVA was used to study responses to two quality of life questions based on whether there were plants or no plants in the nine study sites. It was found that there was no statistical significant difference in the way that people answered the two quality of life questions.

The findings showed that people in the study areas did not rate their quality of life as being more positive or negative depending on if there were “no plants/no windows,” “plants/no windows,” “no plants/windows,” or “plants/windows.” This showed that people might need to be exposed to areas that have plants and/or windows for longer periods of time before there is any effect on their perceived quality of life.

#### *Objective 4*

The fourth objective of the study was to determine and compare reported stress levels in people who were involved in interior use areas that included only windows, windows and plants, just plants, and no windows nor plants.

The stress questionnaire consisted of ten statements. A one-way ANOVA compared responses to individual questions as well as on overall stress test scores. It was found that there were no significant differences in the way that participants answered the individual questions when they were responding within the individual areas that had “no plants/no windows,” “no plants/windows,” “plants/no windows,” and “plants/windows.”

A one-way ANOVA was run on the ten stress test statements based on whether there were plants or no plants in each of the study sites. It was found that there were no statistically significant differences in the way that people answered the stress test statements or on the overall stress test scores based on if there were plants or no plants in the study area.

The findings showed that people in the study areas did not rate their stress levels as being more positive or negative depending on if there were “no plants/no windows,” “plants/no windows,” “no plants/windows,” or “plants/windows.” This showed that people may need to be exposed to areas that have plants and/or windows for longer periods of time before there is any effect on their perceived stress levels.

#### *Objective 5*

The fifth objective of the study was to make comparisons of the types of activities, perceptions of quality of life and stress levels amongst study participants in different study areas based on the demographics of the participants.

Frequency tests determined the demographic breakdown of the 300 study participants including their gender, ethnicity, marital status, age, school classification, and whether the participant was a commuter or not. Analysis of variance tests were conducted to compare responses of survey participants based on their demographic background on the variables of which type of study atmosphere they chose (“no plants/no windows,” “no plants/windows,” “plants/no windows,” and “plants/windows”), what type of activity in which they were involved and why the respondents chose to work in the location. No differences were found in the types of study environments chosen, the types of activities in which respondents were involved, and the reasons why respondents chose to work in the environment. No study areas were more attractive to any particular demographic group, nor did any group choose to work in any study areas for different reason than others.

#### *Researcher Observations and Thoughts*

The findings in the research did not support the stated hypothesis, which was that plants in study areas would reduce the amount of perceived stress in people and increase perceptions of quality of life. However, there were no differences in stress levels and perceptions of quality of life in study areas. Several reasons that the hypothesis was not supported could be due to limitations such as that people need to spend more time surrounded by plants before an effect occurs, and people may be prone to study in certain areas out of habit rather than due to preference for the area.

Another observation made in one study especially was that people were more prone to study in places that had windows but no plants compared to study areas that had plants and windows. This could have been due to the fact that small plants were placed

on tabletops, which took up room on the tables and interfered with study space use.

Therefore, users were less prone to choose those spaces that seemed crowded with plants.

*Recommendations for Additional Research*

1. It is recommended that studies be conducted on people who spend longer amounts of time in interior areas such as doctor offices or airports to observe the impact of plants and windows.
2. It is recommended that studies be conducted on quality of life and stress levels comparing people who can choose their own study areas versus those who are assigned study areas.
3. It is recommended that studies be conducted on quality of life and stress levels in study areas that have no windows, comparing on plants versus no plants in the areas.
4. It is recommended that studies be conducted on quality of life and stress levels in study areas that have windows, with consideration of the views outside the windows.
5. It is recommended that researches consider and tally the lack of people studying in areas (when no people are present) if the study is replicated.
6. If the study is replicated, researchers should try to estimate amounts of time people spend in areas in order to gauge whether plants, no plants, windows, or no windows influence the length of time spent in study areas.

**APPENDIX A:**  
**CONSENT FORM**

**Consent Form**

Dear Students, Faculty, and Staff

I am writing you to ask your help in a research study being conducted as part of my master's degree. You have been chosen to take part in this study because you are currently sitting or standing in one of the approved buildings study areas. This study is part of an effort to learn about peoples' perceptions of quality of life and anxiety/stress in relation to their environment/surroundings. Graduate student Coleman Etheredge and Dr. Tina Cade, from Texas State University, are conducting this study. You can reach them to ask questions about this study at [ce1063@txstate.edu](mailto:ce1063@txstate.edu) and [tc10@txstate.edu](mailto:tc10@txstate.edu).

This survey is voluntary. You can either choose to take part in the study or not. You can quit the study at any time. You may choose to not answer any questions. If you decide not to participate or to not answer a question, there will be no consequences to you. If you choose to participate in the survey, **your name will be entered into a drawing to win a \$25 gift card to Wal-Mart.** The drawing will occur at the end of the week and you will be notified by email if you have won.

If you decide you do wish to take part in the study, please fill out the bottom of the next sheet and the attached survey. It should take about 5 minutes. The survey asks questions about how you perceive your quality of life and your level of anxiety/stress at the time of completing the survey. The survey also asks certain demographic questions. By knowing more about perceived quality of life and anxiety/stress, we can give advice about how to improve them in certain areas.

Your answers are completely confidential. Results from this study will be released only as summaries. No individual's answers can be identified. If you would like a copy of our summary, please contact us.

Please **keep the top copy** of this consent form for your own files and sign the second copy.

Please be sure to have read the above information, asked questions, and received answers to your satisfaction. By signing below, you consent to take part in the study.

Again, thank you very much for helping with this important study,

Sincerely,

Coleman Etheredge  
Masters Candidate

Tina Marie (Waliczek) Cade  
Texas State University

Participants' Name: \_\_\_\_\_

Email: \_\_\_\_\_

Date: \_\_\_\_\_

If you have questions about the research, your rights as a participant, and/or research-related injuries you may contact the Texas State University IRB chair, Dr. Jon Lasser (512-245-3413 – [lasser@txstate.edu](mailto:lasser@txstate.edu)), or Ms. Becky Northcut, Compliance Specialist (512-245-2102).

**APPENDIX B:**

**USE OF SPACE LOG SHEET**

**Use of Space Log Sheet**

Plant Vs. No Plants

**Date:****Site:****Time in:****Time out:**

Windows Vs. No Windows

<b>Physical</b>	<b>Social</b>	<b>Communication</b>	<b>Engagement</b>	<b>Other</b>
Sitting	Group	On Phone	Looking At Plants	Eating
Standing	One-On-One	With Faculty/Staff	Touching Plants	Listening To Music
Sleeping	Game	With Student	Looking Out Window	
Reading	Staff Interaction	With Self	Engaged Nothing	
Writing		Incomprehensible		
Computer Activity		On Computer		
		None		

**APPENDIX C:**  
**QUESTIONNAIRE**

1. When all things in your life are considered, how do you feel today (circle one)?

Very happy      Content      Ok      Not very happy      Miserable

2. Overall, how would you rank the quality of your life? (Defined as, your personal satisfaction with the cultural or intellectual conditions under which you live as distinct from material comfort) (Circle one)?

Very satisfied      Mostly satisfied      Satisfied      Mostly dissatisfied      Dissatisfied

**1 = Not at all      2 = Somewhat      3 = Moderately so      4 = Very much so**

3. I am upset about something that has occurred unexpectedly..... 1    2    3    4

4. I feel that I am unable to control the important things in my life..... 1    2    3    4

5. I feel nervous and "stressed"..... 1    2    3    4

6. I feel comfortable in my abilities to handle my personal problem..... 1    2    3    4

7. I feel that things are going my way..... 1    2    3    4

8. I feel that I cannot cope with all the things I have to do..... 1    2    3    4

9. I feel I can control irritations in my life..... 1    2    3    4

10. I feel that I am on top of things..... 1    2    3    4

11. I feel angered because things are outside my control..... 1    2    3    4

12. I feel that difficulties are piling up so high that I cannot overcome them.... 1    2    3    4

13. What are you working on at this time?\_\_\_\_\_

14. Why did you choose to be in this location?\_\_\_\_\_

15. Do you commute from a neighboring town to Texas State University (circle one)?    Yes    No

16. What is your classification (circle one)?

Freshman      Sophomore      Junior      Senior      Grad student      Unclassified faculty      Staff

17. What is your age?\_\_

18. What is your ethnic group (circle one)?

Caucasian    African-American    Native-American    Hispanic-American    Asian-American    Other  
(Please Specify)

19 What is your gender (circle one)? Male Female

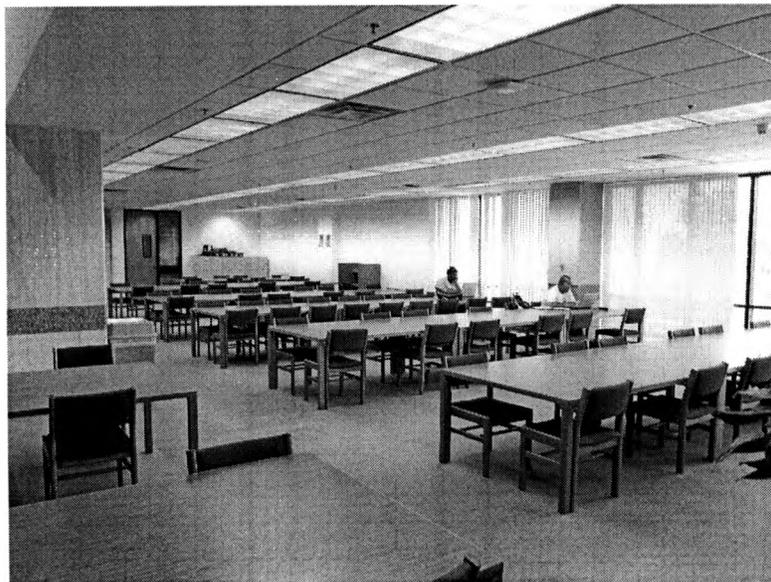
20. What is your marital status? \_\_\_\_\_

**APPENDIX D:**

**STUDY AREA PICTURES**



Second floor large area library plants/windows



Second floor large area library no plants/windows



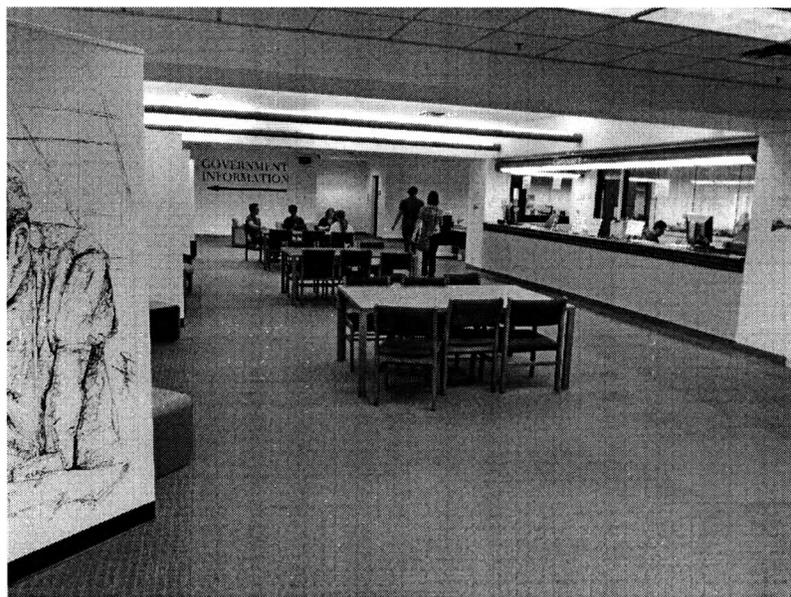
Second floor small area library plants/windows



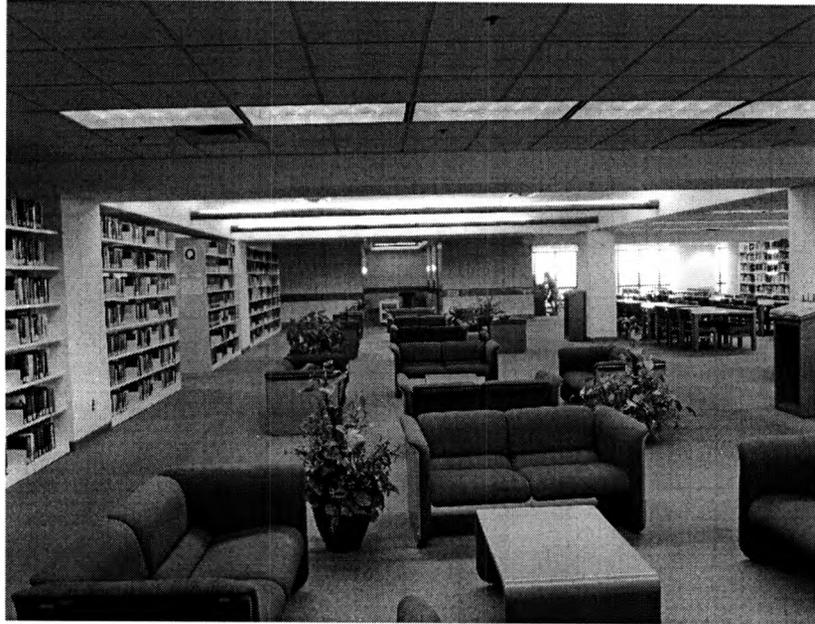
Second floor small area library no plants/windows



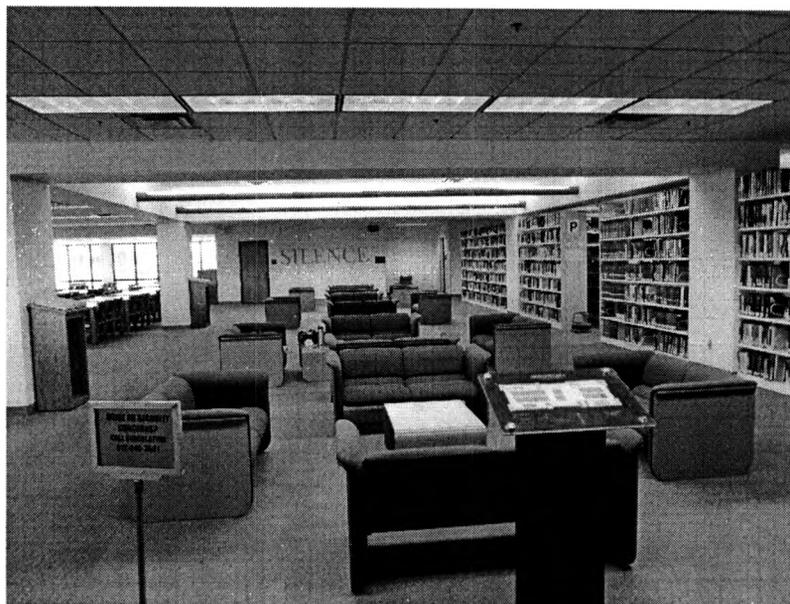
Fourth floor library plants/no windows



Fourth floor library no plants/no windows



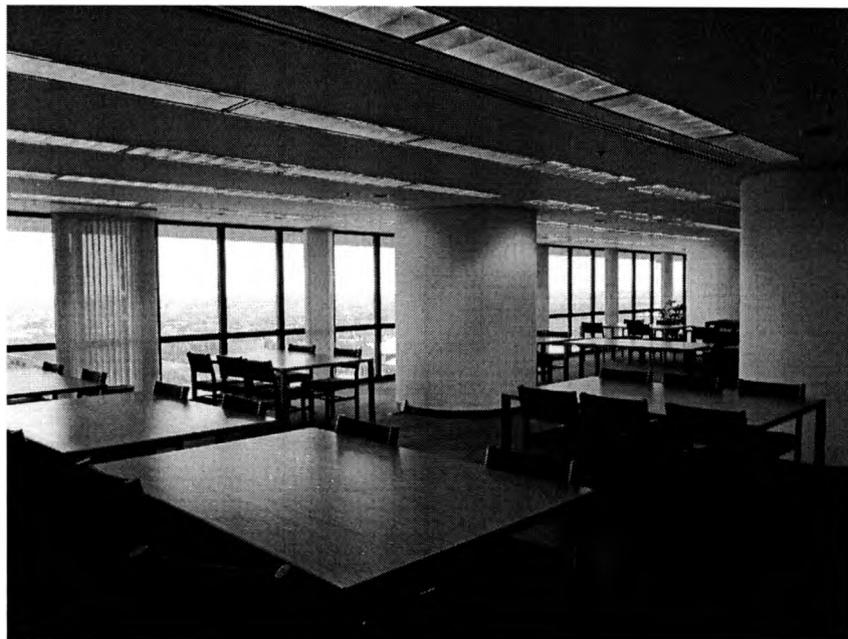
Sixth floor library plants/no windows



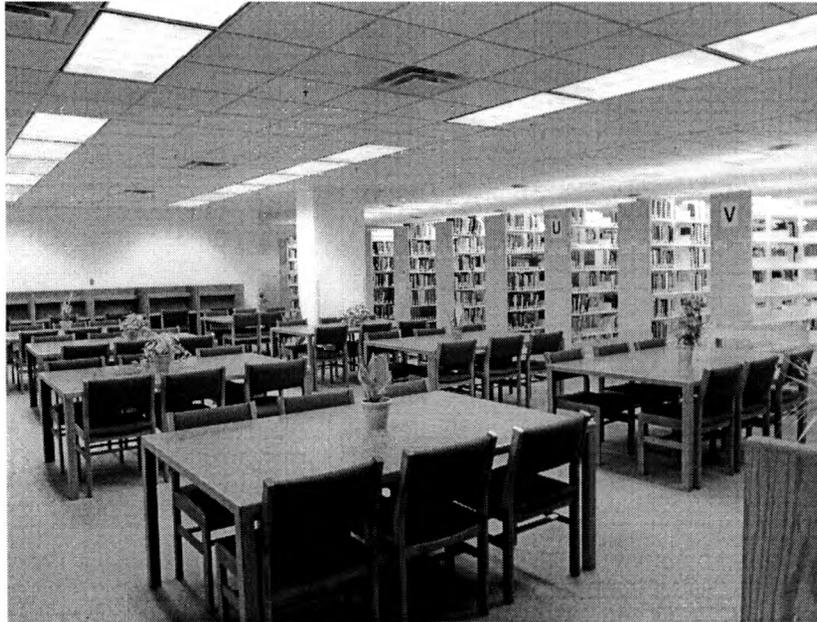
Sixth floor library no plants/no windows



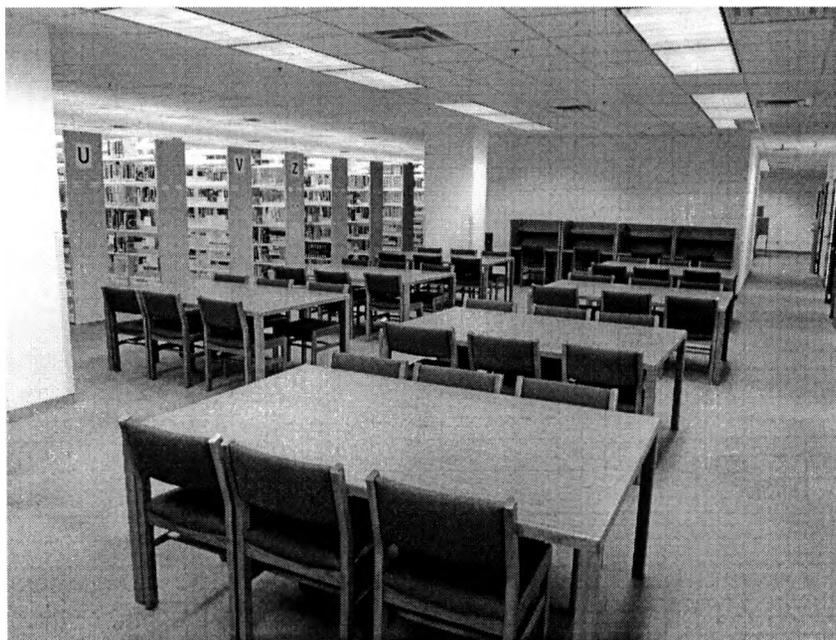
Seventh floor north side library plants/windows



Seventh floor north side library no plants/windows



Seventh floor south side library plants/no windows



Seventh floor south side library no plants/no windows



Seventh floor private room library plants/no windows



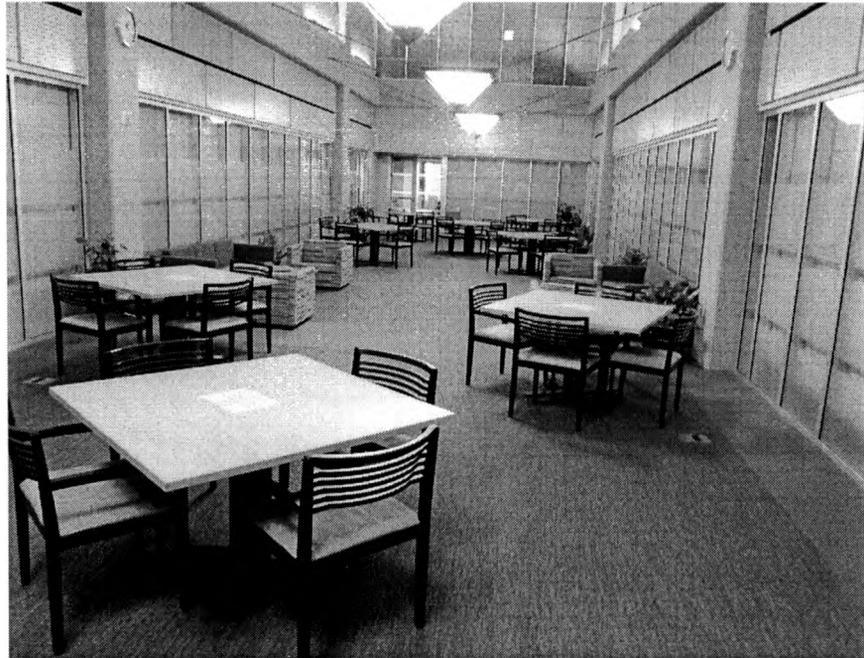
Seventh floor private room no plants/no windows



First floor business building plants/windows



First floor business building no plants/windows



Fourth floor business building plants/no windows



Fourth floor business building no plants/no windows

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