

Biophilia and Educational Satisfaction:
Analyzing the Performative Benefits of Courtyards
In University Settings Through the Lenses of Biophilic Design

by

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ABSTRACT

This research aims to investigate the effect of campus courtyards on students' satisfaction with education. It will look into two different types of courtyard within the Arizona State University. One courtyard space has more elements and attributes of biophilic design and the other has less. In addition, this paper will provide guidelines for designing courtyards that would improve student's satisfaction with education. The Methodology used is survey handouts to students after the researcher selects the two types of courtyards by observation. The participant in this study are randomly picked young adult college students (n=60). The results indicate a positive effect of biophilic design on student's satisfaction with education in courtyards. Furthermore, guidelines for designing courtyards based on biophilic design elements and attributes are suggested.

Keywords:

Students, biophilic design, satisfaction with the educational experience, nature, courtyard, outdoor environment.

This dissertation is dedicated to my mother who surrounds me with her words of encouragement, to the memory of my loving father who used to remind me every day how much he is proud of me, to my supportive husband who helped me through this journey while studying.

To my beloved family and friends, Thank you.

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CHAPTER 1

INTRODUCTION

1.1 Background

Biophilia is known as the connection between humans and nature and other forms of life. In Greek, Bio stands for Life and Philia means Love. Edward Wilson used the term in his book *Biophilia* (1984) which was advancing the concept of biophilia. Before that, the psychoanalyst Erich Fromm used the term biophilia and described it as “The passion of life and of all that is alive” in his book *The Anatomy of Human Destructiveness* (1973) (Rogers 2019). In architecture and environmental design, it is a strategy of sustainability that cares about reconnecting users with nature. The nature meaning is beyond trees and birds, it is counted as the physical world around us and generally it is life and natural world in all forms. This connection between human and nature can be direct, indirect and the experience of place and space (Kellert 2018).

With the design evolving over time, many designers and architects have encouraged the separation between human and nature in the modern built environment. As a result, many non-sustainable solutions in designs have emerged such as, chemical pollution, negative energy consumption as many other anti-environmental outcomes (Kellert 2008). Therefore, all professions involved in designing educational buildings must always be conscious about the benefits of increasing the exposure of humans to nature which this study will offer.

It is indicated that green spaces experienced as nature also have a great impact on human health and well-being as demonstrated by one study in England on participants living in areas exposed to different green spaces (Mitchell and Popham, 2008). The study

used mortality records caused by some diseases as the criteria to be measured. The results indicated that causes of death in people exposed to a greater green space are fewer than those exposed to less green spaces.

In 2017, another study was made to investigate if nature can enhance the relationship between well-being and natural beauty (Capaldi *et al*, 2017). The research was made by using several scales to measure well-being including the natural beauty subscale of the engagement with beauty scale, and 14-item Mental Health Continuum Short Form (MHC-SF) and the 5-item Presence of Meaning subscale from the Meaning in Life Questionnaire (MLQ-P) on college students in three cultures. they found that there is significant positive relationship between well-being and engaging with natural beauty. This study indicates that it is very important to be exposed to natural beauty to enhance one's well-being.

What is more important than human health? *Health* does not mean only physical or mental soundness, but it also means relieved spiritually, socially, culturally and economically and this list gives life more balance (Honari and Boleyn, 1999). Being healthy also means being able to produce and contribute, and an excellent example of that is educational settings. In education fields, students must be provided with a healthy atmosphere which offers them the best opportunity to learn and makes the studying experience more appealing.

Why courtyards? In 2015, a study aimed to look into the type of activities done in a university courtyard on college student using six different campuses (Zhang *et all*, 2015). The results show that the main activity practiced in the courtyard was studying followed by meeting with another person and resting alone. This study shows how much important

a courtyard is in the student's educational life. Therefore, universities should pay more attention to the courtyards that students use throughout their academic lives

This paper combines these two independent variables: biophilia and courtyards at ASU campus and one dependent variable which is satisfaction with educational experience, hoping to gain an understanding of the best environment for students educational experience and physical and mental well-being.

The expected results will be illustrating a positive impact of biophilia on students in university settings. In addition, they would provide enough information to help improve many school environments.

1.2 Scope | Limitations

This research is limited to studying the natural elements of biophilic design including environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships and evolved human nature relationship (Kellert 2008). These six elements have more than 70 different attributes listed under them, and will be explained further in this paper.

This paper discusses the interaction between humans and natural features such as trees, grass, water features, and all-natural components surrounding the users. Some of the results of this research might contribute to an interior atmosphere since it is attached to the exterior spaces. This paper is also limited to the Arizona State University campus on randomly selected students.

1.3 significance | Justification

This study is significant on many levels. First, it assesses the relationship between students and nature, and the students' sense of satisfaction resulting from that relationship.

It also tests the effect of nature on student health and well-being which helps in increasing the performance level of a student. In addition, this research investigates the elements that help keep the students satisfied with their educational experience. Furthermore, the research is curious about the results coming from exploring the application of biophilic design element in a school building.

There are several reasons that justify why this research should be conducted. One reason is to promote health and well-being and help improve schools' establishments since it is the source of knowledge and science. In addition, to increase students' participation to school and create a cause of why they should enjoy going to their classes. In addition, this study is important because it highlights how nature affects the scholar satisfaction, acceptance and what to obtain from this unique connection results. Another reason which is considered more general than the previous ones is that we must allow students to react and discover their natural environment by designing a space where they can learn from and be a part of.

“As students face an increasingly globalized economy, demands for personalized and authentic learning through engagement in meaningful and real-world problems suggest that architects and planners must consider how technology and distributed models of learning will shape the form and structure of schools for the future.”
(Million *et al*, 2016, p75)

1.4 Research Questions.

This research is conducted to investigate two major questions that are sequential in nature and they are:

1. How do existing courtyards contribute to the satisfaction of educational experience of students in universities?

Rational: there is limited research that describe how existing courtyards influence students' well-being and educational experience.

2. What are the improvements that could be applied to the courtyard at educational establishment to enhance students' satisfaction of educational experience?

Rational: to gain an understanding of what are the improvements needed to be applied to a school's atmosphere to make it a suitable learning environment for students, since this research cares about suggesting some changes to the educational environment.

1.5 Operationalizational Terms

- **Biophilic Design:**

A part of the of biophilia concept that incorporates natural light, vegetation, natural views and other experiences of the natural world into the modern built environment.

- **Satisfaction with the educational experience:**

The level of comfort a student reaches when they are pleased with the environment where they receive learning process.

- **Nature:**

It is the surrounding environmental features that is augmented further by earth, air, light and living creatures including humans, animals and vegetation.

- **Courtyard:**

It is the space formed by buildings or vegetation located in university campus where various activities take a place such as, studying and socializing. It could be in any size or shape.

- Well-being:

It is the state of a groups or individuals where it indicates positivity when it's high, and negativity when it is low.

1.6 Research variables

This part highlights the research framework and explains the study variables and they are; biophilic design, educational satisfaction and courtyards as Figure (01-01) illustrates. The relation between these three variables depends on the answers to the main questions of this paper. As this research suggests, the independent variables are biophilic design and educational satisfaction whereas the dependent variable is courtyard. Educational satisfaction and biophilic design.

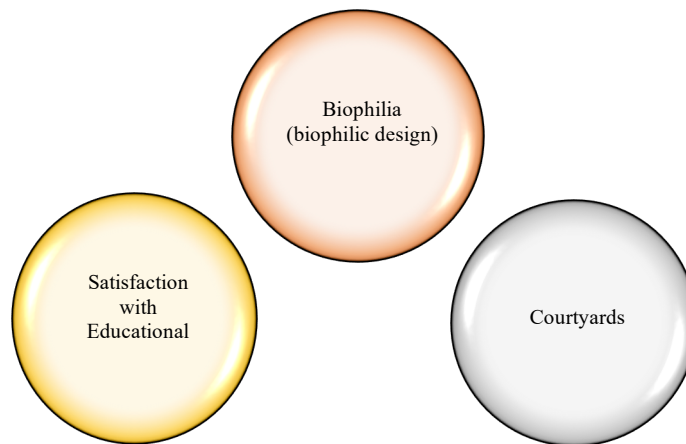


Figure (01-01): Study variables

1.5 Conceptual Framework Descriptors

Biophilia is defined as the connection between the human and life in all its forms. The artifact of this research is to identify the possible effects biophilic design has on student's satisfaction with the educational experience as well as to create guidelines to improve a human built environment using biophilic design specifically at universities. This object was selected because of the importance of the environmental design and what it contributes to the health of body and mind. The context of this paper is courtyards within the educational establishment. It focuses on the performative benefits of using the courtyard and the enhancement of the architectural space. In this project, courtyard are the spaces which student usually use for different purposes like, studying, socializing, or simply moving through the campus. It is a mix of social, physical, ecological human built environment. These courtyards do not only have functional uses but also serve as an aesthetic integration. The benefit of this application is an increase in the student's educational satisfaction, comfort and well-being. Educational satisfaction is the high level of comfort reached by a student by going through an excellent educational experience as represented in Figure (01-02).

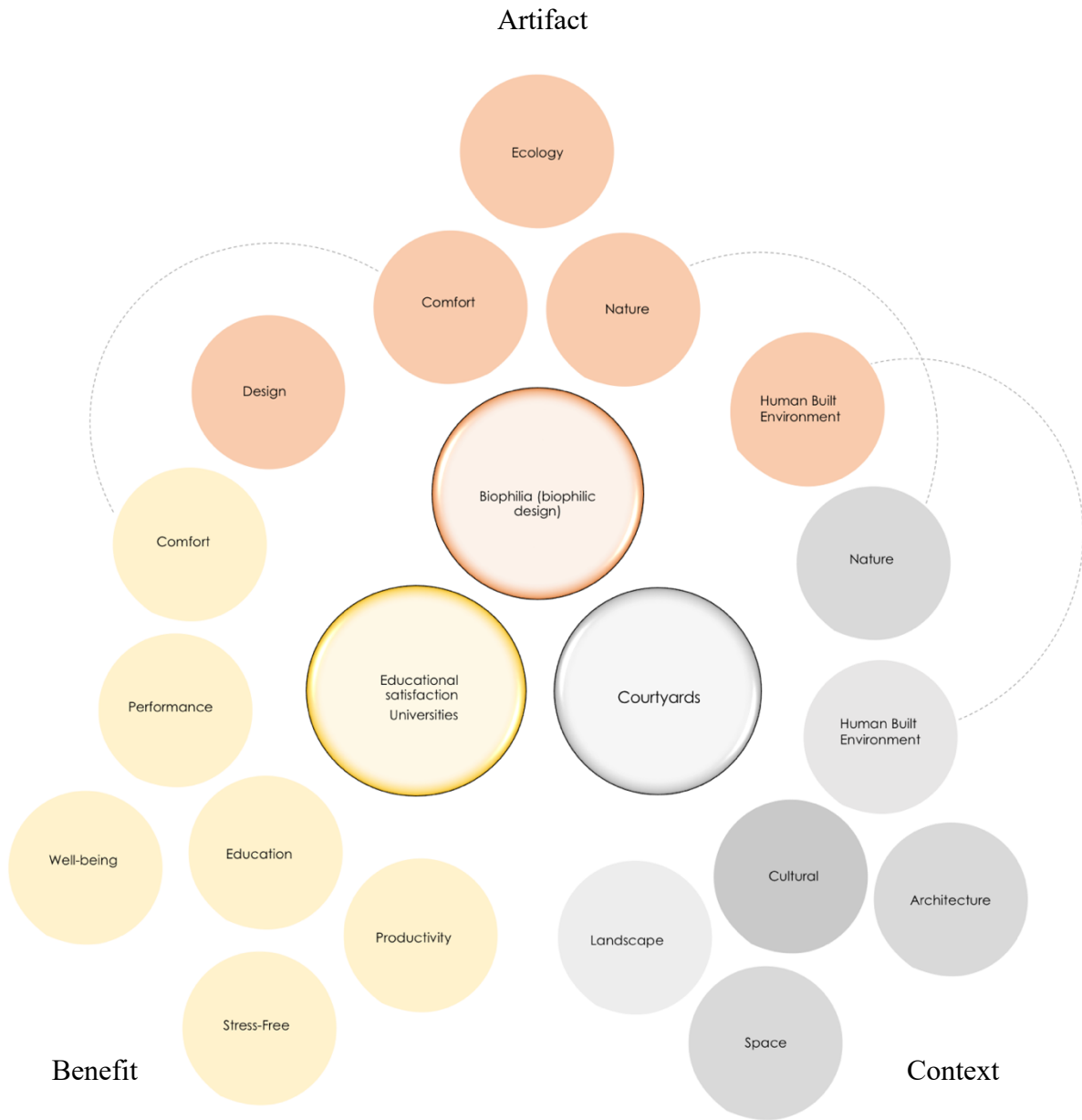


Figure (01-02): Conceptual Framework descriptors

1.7 Conclusion

This chapter highlights five aspects of this thesis. It provides a background of the research topic. It also discusses the importance of conducting such a research. In addition, it explains the scopes and limitation of the study. It also introduces the conceptual framework variables and descriptors as it explains the type of expected relation between them. Furthermore, this section highlights the research questions to be investigated. Finally, it provides some important keywords definitions.

In later sections, more detailed information about the variables will be introduced as a focused quantitative data is implemented to answer the main research questions thoroughly. Furthermore, after the result analysis, the relationships between the research variables will be determined and a conceptual framework will be illustrated.

CHAPTER 2

Review of the Literature

2.1 Introduction

The theory of Biophilia has existed for decades. It is not a new concept immersing however; it can be redeveloped over time. It is beyond the concept of nature's connection to humans; it is what makes a person comfortable in some places more than the others. Evidence shows that biophilic design has a couple of positive impacts on humans. It influences productivity, enhances concentration, reduces stress, helps in brain relaxation and it affects emotions (Ryan *et al*, 2014).

in 2015, research was focused on the review of “the practice of biophilic Design” by Stephen Kellert and Elizabeth Calabrese. The author examined the experience and attributes of biophilic design closely and they are: Direct and indirect experience of nature and experience of space and place. The results showed that there is much more evidence that supports a particular attribute like the incorporation of natural elements (Gillis and Birgitta 2015).

Courtyards designed in ancient Islamic houses depend on the description of heaven from the Quran in their design. It considers the nature shades, calligraphy and pleasant sounds, a layout in accordance with the house lines and all aesthetic elements of paradise (Edwards 2006). Since these kinds of courtyards care about nature inspired from paradise, it is linked to biophilic design. In 2017, Bukhari and Khanam conducted a study That investigates the relationship between university students' performance and several factors like emotional intelligence, optimism, life satisfaction and self-efficacy (Bukhari and

Khanam 2017). The results indicated that all these factors lead to a better academic performance except for emotional intelligence.

2.2 Biophilic design

In a book entitled *Biophilia*, the biologist Edward O. Wilson was the first who worked on advancing the concept of biophilia (Kellert 2012). The same term was used in 1973 by Erich Fromm, a psychologist who disputed that human health is related to the love of life. In Greek, Love of life is translated as biophilia.

The term Biophilia was discussed earlier in this proposal and is defined as the interaction between people and nature. So, what is biophilic design? From what it sounds, it is the incorporation between nature and modern built environment. Why study biophilia? It is because there are limited numbers of research discussing the relationship between nature and college students and that is very important not only for their health, but also for their academic experience.

In relation to nature, many concepts and denotations emerged to help in advocacy human made products such as biomimicry. This concept uses the working mechanism of non-human world of animals and plants to help build more useful products. With the help of the nature, human is now able to deal with their need more efficiently.

Our connection with nature is what defines us as human. From the past, using natural materials and recourses is what helped humanity to survive. Up until nowadays, nature continues to prove the great effect on people health, well-being, happiness and satisfaction.

The writer of *Birthright*, Stephen R. Kellert says in his book:

“We will never be truly healthy, satisfied, or fulfilled if we live apart and alienated from the environment from which we evolved.” (Kellert 2012, px)

As mentioned in the previous section, exposure to nature can be direct, indirect and the experience of place and space (Kellert 2018). The direct connection can be through real interaction between human and nature such as natural lighting or weather. The indirect connection can be via exposing a human to a picture representing natural feature similar to the ones we often hang in our indoor livings. The experience of place and space is simply the perception of characteristics of environmental nature like wayfinding.

In 2017, a study made to investigate if nature can enhance the relationship between well-being and natural beauty (Capaldi *et al*, 2017). The research was made by using more than one scale to measure well-being like the natural beauty subscale of the engagement with beauty scale, and 14-item Mental Health Continuum Short Form (MHC-SF) and the 5-item Presence of Meaning subscale from the Meaning in Life Questionnaire (MLQ-P) on college students in three cultures. they found that there's a significant relationship between well-being and engaging with natural beauty and this relationship was found positive as expected.

Furthermore, a study entitled: "Beyond knowing nature: Contact, emotion, compassion, meaning, and beauty are pathways to nature connection" was made to investigate the natural activities built around the biophilia hypothesis nine values (Lumber *et al*, 2017). Two online surveys were released and later supported by a third one to a total of 393 participants. The results indicated that pathways that helps with nature connectedness are: Contact, emotions, compassion, meaning and beauty.

In order to ensure that nature has a positive effect on human health and well-being, we must know how exactly to implement it right in human-building environment. In 2017, a research was made to it shows how to apply certain natural events within biophilic design

framework on the environment. In addition, to explore how can we implement the biophilia hypotheses design into environment (Orman *et al*, 2017). The research chooses to analyze 3 different areas and they are USA, Brazil and Japan designed by known architects. The variables used in this paper were developed by Biophilic design framework book by Stephen Kellert and Elizabeth Calabrese and they are: Direct and indirect experience of nature and experience of space and place, Each one has a list of contributes. In general, based on the application of biophilic design in the three locations with different situations, it was indicated that (Kellert and Calabrese 2015) and the application of biophilia hypothesis is rational and applicable in any region or context

2.2.1 Benefits of connecting with nature

Many studies were conducted to contribute to the fact that nature is healthy for our lifestyle on many levels like Health and well-being, happiness, stress relief, re-covering from diseases. So, is this effect is constrained with the actual nature only? is actual nature's effect different from a virtual one?

One research conducted three different studies to investigate a mediator between nature and well-being (Mayer *et al*, 2009). In addition, there were two more secondary questions. The first one is to find out if nature exposure helps in the process of a complicated socioemotional of reflecting on life matters. The second question was to explore the difference between actual and virtual nature for accruing benefits. In the first study, there were four different measurements used on the participants and they are: attention capacity measure, positive and negative affect schedule, connectedness to nature scale and self-awareness measure. The results backed up connectedness to nature scale to be a mediator of nature effect on well-being despite that attention capacity did not show

positive effect. In the second study, videotapes and some other additional measures were used to find the difference between actual and virtual nature. It was conceived that the participants in virtual nature conditions felt less positive than the participants exposed to the actual natural environment. However, the difference was not significant because the ability to reflect was affected in both groups exposed to actual and virtual natural conditions. As an extension to the second study, the third one was about finding if people exposed to the real nature had more psychological benefits from people exposed to videotaped nature and the results came out simply as: Yes they did.

2.2 Satisfaction with educational experience and well-being and

Education is a process of learning and passing knowledge. Without considering factors affecting education negatively or positively, this process will be hard to develop. Therefore, few studies were concerned about examining the elements affecting educational experience and the best way to overcome situations that would make the process of learning limited or less useful.

When the well-being status of an individual or a group is high, it indicates positivity and when it is low, it indicates negativity. In many studies, well-being can be measured using variety of scales. A study was made in 2017 to investigate if nature can enhance human well-being (Capaldi *et al*, 2017). The research used various scales to measure well-being on college students in three different cultures. The results indicated that there is a significant relationship between well-being and engaging with natural beauty and this relationship was found positive. As presented in this paper, the nature perception reduces stress and enhances productivity. In return, stress is negatively correlated with student satisfaction of educational experience as one study predicted (Puri 2016).

In psychology, the interest of studying environmental factors' effect on health and well-being is increasing. In research published in 2013, Mackerron and Mourato (2013) investigated the link between the individual environment and the subjective well-being (Mackerron and Mourato 2013). They wanted to know what influence does the outdoor leave on participants happiness. As a research tool they developed an app used by Apple users to survey people. They found that participants are happier outdoors than they are in human built environment. This evidence is added to other more in showing that there is a positive relationship between green areas and subjective well-being.

In china, shanghai botanical garden, a research was made on urban residents to determine the influence of the green areas on their environmental satisfaction and physiological status (Qin *et al*, 2013). Five different areas in size and color where chosen and one additional no vegetation area was also included. The researcher used a questionnaire to measure the residents' satisfaction where he collected 249 surveys from participants. In addition, he used physiological measurements like the (EEG) and the (ECG) on 64 visitors of the botanical garden. The findings of the research indicated variation in results among the five spaces where color, scent, height, formation and overall area satisfaction was tested. The highest overall satisfaction was found in the colorful areas then the light green area followed by green grass areas then the pink spots, and lastly is the forest green color areas. No vegetation areas where found the lowest in satisfaction. Although the colorful area is the smallest area tested, it was where the satisfaction was found the highest. Furthermore, the relationship between psychological parameters and environmental satisfaction was found not significant.

In 2008, an investigator studied the association between the perception of local environment, neighborhood satisfaction and self-related health using a cross sectional survey from (PLACE) in Austria including socio-demographics, perceived attributes of the environment, neighborhood satisfaction (NS) and mental health status (Leslie and Cerin 2008). They found that the mental health is related to the perception of the environmental characteristics. Mental health can be increased when aesthetic environment is perceived by residents.

As one research investigated the effect of three different gardens on university student (Elsadek *et al*, 2019). They found out that among the three different styles, students choose the one with more natural looking. The results indicated how significant nature is on students' perception. In addition, the research reported different responses to the three garden styles not only by questionnaires but also by testing scholars eye movement and heart rate.

Some studies started to concede biophilia more in green building systems to promote health and well-being. In 2019, a research was made to support moving green building rating to a human oriented instead of energy-oriented rating tool using concept of biophilia (Xue *et al*, 2019). In this study, the researcher compared strategies of biophilia and six representatives of green building rating tool. They found that almost 85% of biophilic strategies are related to Green Building Rating Tool (GBRT) not including some strategies on outdoor human experience that are found significant. Moreover, the study presented guidelines to support shifting the GBRTs from energy oriented to a human centric with a biophilic approach in which it enhances health and well-being.

Since students are exposed to pressure during their educational life, many investigators were concerned with finding out what can reduce the tension and make students campus life less stressful (Ulrich *et al*, 1991). To measure the effect of nature on stress, 120 participants were exposed to a stressful video. After that they were divided to two groups. The first group was exposed to a natural environment video while the other group viewed an urban environment video. After measuring participant stress levels, the results indicated that the group exposed to natural environment video recovered faster from stress than the other group exposed to the urban setting. Thus, nature can act as a stress reducer when incorporated at an educational setting such as universities.

Moreover, further studies in relation to stress were brought to light to investigate the duration of exposure to nature in dwellers and the change in their stress level (Hunter 2019). Hunter, Gillespie and Chen used salivary cortisol and alpha-amylase to measure the change in stress levels of participant. The result analysis indicated stress reduction in both biomarkers with response to nature.

2.4 Courtyards

With the emerging of many environmental problems there comes our role to find a solution that minimize the effect of them or to stop it from growing worse on the environment we live in since there is a major influence of our surrounding on our health, happiness, stress and all. The discovery of Urban Heat Island by Luke Howard simply states that the temperature in the urban areas are much greater than the one in rural areas. That is simply because greenery minimize the temperature of the weather (Taleghani 2014). The lack of vegetation warms up cities and there comes the significance of green areas and plantation.

With the improvement of the human built environment comes an obligation to promote healthy habits and comfortable surroundings. Clearly, universities with large number of young adults, faculty and staff are the kind of establishments where we apply healthy habits and comfortable surroundings to help users through their academic journey. Courtyards are one example of spaces where students spend much of their times. Therefore, these spaces must not only be comfortable, but also healthy, organized and well-studied. Courtyards are considered transitional spaces, an area surrounded by many buildings or one big building and there is a covered area which is called patio (Taleghani 2014). In this research (Biophilia and educational satisfaction), the area targeted is a non-covered large space.

A study made in 2008 shows how it is important for children to have open green space at schools and the role that it plays in promoting their physical activities (Dyment 2008). It is a part of our nature as human being to interreact with nature around us. Old or young, we all go back to our nature sooner rather than later

As one study shows, courtyards in Islamic architecture has specific characteristics. They must be in a certain size to allow the sun to enter the space but at the same time protect from extreme heat during summer (Edwards 2006). These courtyards do not only have functional uses but also serve as an aesthetic integration since they are designed with consideration towards the whole building's lines.

In a research study made in 2017, a researcher started to investigate the traditional courtyards houses in Iran to use them as a module for sustainability (Soflaei *et al*, 2017). A very detailed analysis including the building orientation, size and height of walls, properties of openings, dimension of enclosed and open spaces, and dimension of the

natural bodies like water and soil. Basing on the six principles of green buildings of Vale and Vale (1991) and they are:

Principle 1: Conserving Energy

Principle 2: Working with climate

Principle 3: Minimizing new resources

Principle 4: Respect for users

Principle 6: Holism

The results indicated that the traditional courtyards characteristics comply to all principles of green buildings of Vale and Vale (1991).

The existence of courtyards does, in fact, reduce heat by providing shades by building blocks (Taleghani 2014). We would simply make a use of buildings as a part of our contribution to solve environmental phenomenon such as thermal comfort or UHI.

In Taleghani's research (2014) (Dwelling on courtyards) the main objectives were to clarify that courtyards provide indoor energy efficiency and thermal comfort therefore outdoor thermal comfort for users within the courtyards in residential buildings and to discover if the courtyard components of vegetation, orientation and physical characteristics would provide thermal comfort and energy efficiency for the users in Netherlands. The results indicated that courtyards with higher volume to surface ratio has the least exchange of heat with the outdoors with less heat gain in summer and less heat loss in winter. The results also showed that some orientations offer more comfort outdoors like the North-South and the East-West orientation (Taleghani 2014). This research provides good reference in studying the best orientation, building height and surface area to the outdoor courtyard environment needed for environmental comfort and energy efficiency.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The purpose of this research is to explore the effect of biophilic design on students' satisfaction with educational experience taking the courtyard space as a testing location. To carry out this study, the researcher will choose two courtyard sites within Arizona State University- Tempe Campus illustrated in Figure (03-01). These two courtyards must be similar in terms of size and number of surrounded buildings. There are many spaces used by students in Arizona State University. After searching and asking landscape architects within ASU, the courtyards with similar physical characteristics found are:

- Social Sciences Building on Cady Mall at Tyler
- Farmer Education Building on Forest Mall at Gammage Parkway
- Memorial Union – west courtyard off Cady Mall
- Secret Garden – Dixie Gammage Hall
- Life Sciences Courtyard – LSA – Palm and Tyler
- Engineering G Wing Courtyard
- ISTB 2
- Armstrong Hall
- McCord Hall
- Barrett College
- Sonora Center
- Hassayampa Academic Village

And the two chosen locations are: McCord Hall and Barrett College since they match the needs of the topic of this paper.

3.2. Method

Two main spaces will be selected to conduct this research and they are: Courtyards with more attributes of biophilic design presented, and courtyards with less attributes of biophilic design presented than the first one. Scholars visiting these courtyards regularly will receive a survey that contains questions regarding their satisfaction with the educational experience. To choose the best locations to conducting this study several courtyards will be observed to select the best with higher and lower biophilic design considerations.

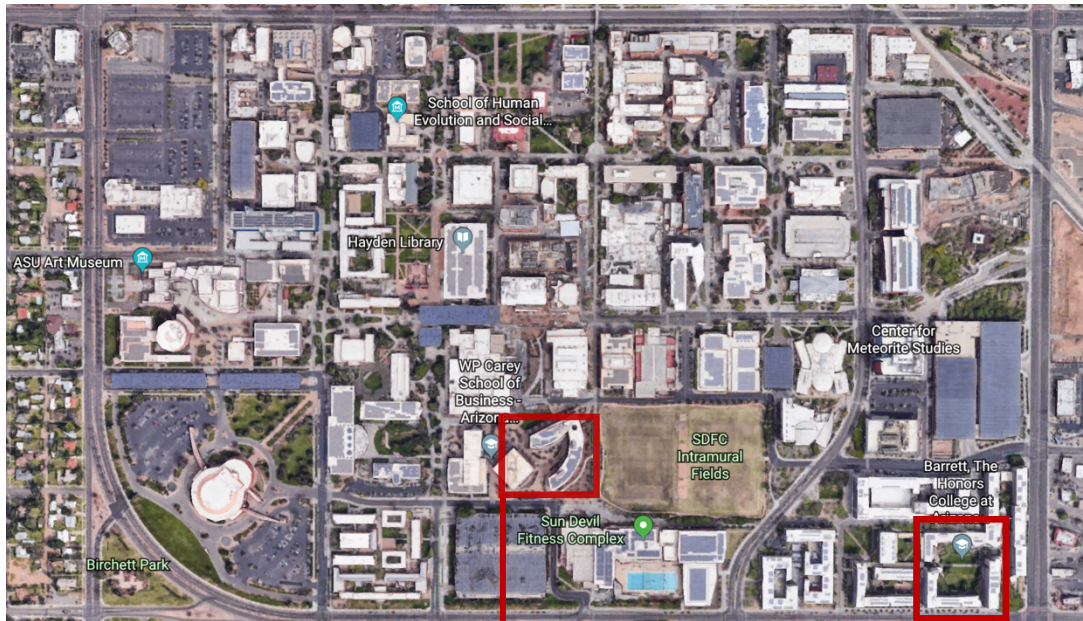
There are six elements and more than 70 attributes of biophilic design assessed in the selected locations for the study (Kellert 2008) as listed in Table (03-01). The study will be carried out during spring season from March 2019 until May 2019 taken in consideration the weather conditions, sun, wind as well as noise levels. The participants of this research are the regular visitors to these courtyards from young adults and they will be chosen randomly.

Environmental features	Natural shapes and forms	Natural patterns and process
<ul style="list-style-type: none"> ▪ Color ▪ Water ▪ Air ▪ Sunlight ▪ Plants ▪ Animals ▪ Natural Materials ▪ View and vistas ▪ Geology and landscape ▪ Habitat and ecosystem ▪ Fire 	<ul style="list-style-type: none"> ▪ Botanical motifs ▪ Trees and columnar support ▪ Animal (mainly vertebrate) motifs ▪ Shells and spiral ▪ Egg, oval and tubular forms ▪ Arches, vaults, domes ▪ Shapes resisting straight lines and right angles ▪ Simulation of natural features ▪ Biomorphy ▪ Geomorphology ▪ Biomimicry 	<ul style="list-style-type: none"> ▪ Sensory variability ▪ Information richness ▪ Age, change and the patina of time growth and efflorescence ▪ Central focal point ▪ Patterned wholes ▪ Bounded spaces ▪ Transitional spaces ▪ Linked series and chains ▪ Integration of parts to wholes ▪ Complementary contrasts ▪ Dynamic balance and tension ▪ fractals ▪ Hierarchically organized ratios and scales
Light and space	Place based relationship	Evolved human -nature relationship
<ul style="list-style-type: none"> ▪ Natural Light ▪ Filtered and diffused light ▪ Warm light ▪ Light pools ▪ Light as shapes ▪ Spaciousness ▪ Light pools ▪ Light and shadows ▪ Reflected light ▪ Special variability ▪ Special harmony ▪ Inside-outside spaces 	<ul style="list-style-type: none"> ▪ Geographic connection to place ▪ Historic connection to place ▪ Ecological connection to the place ▪ Cultural connection to the place ▪ Indigenous materials ▪ Integration of culture and ecology ▪ Spirit of place ▪ Landscape orientation ▪ Landscape featured that defines building form ▪ Indigenous material ▪ Avoiding place-lessness ▪ Landscape ecology 	<ul style="list-style-type: none"> ▪ Prospect and refuge ▪ Order and complexity ▪ Curiosity and enticement ▪ Security and protection ▪ Mastery and control ▪ Affection and attachment ▪ Attraction and beauty ▪ Exploration and discovery ▪ Information and cognition ▪ Fear and awe ▪ Reverence and spirituality

Table (03-01): Elements and Attributes of Biophilic Design (Kellert 2008, page 15)

3.2.1 Site observation and selection

The chosen location according to the list of biophilic design elements and attributes will be: Location A_McCord Hall and Location B_Barrett College. The Map illustrated in figure (03-02) shows the two locations in Tempe Campus and the dots represents the spots of students when they were surveyed. (For observation notes, see appendix A and B).



McCord Hall



Barrett College

Figure (03-02): Location A_McCord Hall and Location B_Barrett College in Tempe Campus. ● Spots of surveyed students.

1. Location A: McCord Hall

The observation of this courtyard took a place in a cloudy day where the temperature was 23 Celsius. The space is divided into smaller spaces by a curved line in the floor that turns into a short wall or sitting place in some areas. There are some trees providing shaded sitting areas and water fountain. The area is surrounded with buildings and have a direct connection to a street. During observation, smell of fresh air and sound of water and birds was also recorded. Couple of photographs were taken to be analyzed for elements and attributes as illustrated in Table (03-03A-B). The elements and attributes were noted and summarized in Table (03-02).

Environmental features	Natural shapes and forms	Natural patterns and process
Water Air Sunlight Plants Animals Natural materials views	<ul style="list-style-type: none"> ▪ Botanical motifs ▪ Trees and columnar support ▪ Shapes resisting straight lines and right angles ▪ Tubular forms (the fountain) 	<ul style="list-style-type: none"> ▪ Sensory variability ▪ Central focal point ▪ Bounded spaces ▪ Transitional spaces ▪ Hierarchically organized ratios and scales
Light and space	Place based relationship	Evolved human -nature relationship
<ul style="list-style-type: none"> ▪ Natural Light ▪ Filtered and diffused light ▪ Light pools ▪ Reflected light ▪ Warm light ▪ Light as shapes ▪ Special harmony ▪ Light and shadows 	<ul style="list-style-type: none"> ▪ Avoiding placelessness 	<ul style="list-style-type: none"> ▪ Prospect and refuge ▪ Security and protection ▪ Mastery and control

Table (03-02): Elements and Attributes from Location A

Locaton A pictures	Element and Attribute
	<p>Environmental features:</p> <ul style="list-style-type: none"> -Plants ● -Water ● -Natural materials (stones at the water fountain) <p>Natural shapes and forms: ●</p> <ul style="list-style-type: none"> -Botanical motifs ● -Trees and columnar support ● -Tubular forms (the water fountain)
	<p>Natural shapes and forms: ●</p> <ul style="list-style-type: none"> -Shapes resisting straight lines and right angles ● <p>Natural patterns and process: ●</p> <ul style="list-style-type: none"> -Hierarchically organized ratios and scales ●

Table (03-03A): Analyzed Photographs of Location A


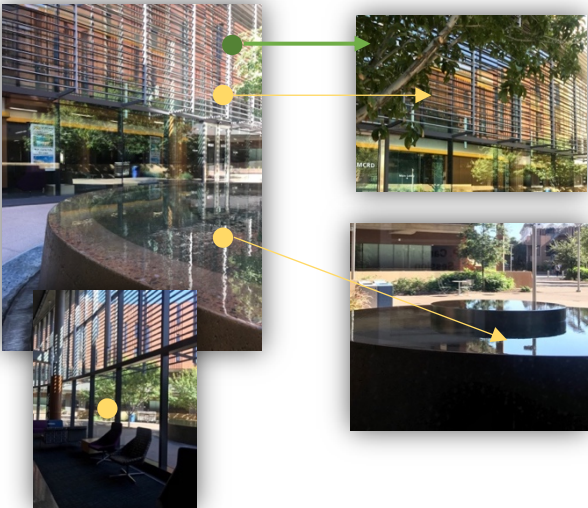
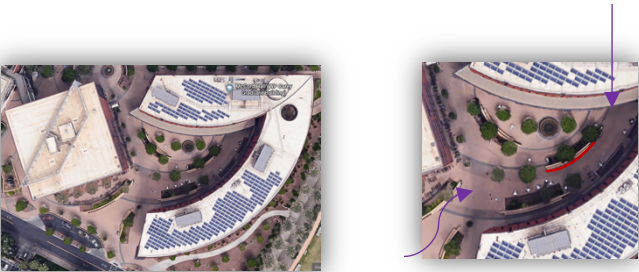
Locaton A pictures	Element and Attribute
	<p>Environmental features: ●</p> <ul style="list-style-type: none"> -Sunlight -Views <p>Light and space: ●</p> <ul style="list-style-type: none"> -Warm light -Light as shapes -Light and shadows -Light pools -Light and shadows <p>Natural patterns and process: ●</p> <ul style="list-style-type: none"> -Bounded spaces -Transitional spaces
	<p>Light and space: ●</p> <ul style="list-style-type: none"> -Reflected light (water surface and building glass) -Filtered and diffused light (through trees) -Inside- outside space <p>Natural patterns and process: ●</p> <ul style="list-style-type: none"> -Central focal point (water fountain)
	<p>Evolved human -nature relationship: ●</p> <ul style="list-style-type: none"> -Prospect and refuge -Security and protection -Mastery and control <p>Place based relationship: ●</p> <ul style="list-style-type: none"> -Avoiding place-lessness - Special harmony

Table (03-03B): Analyzed Photographs of Location A

2. Location B: Barrett College courtyard.

The observation in this location happened in a cloudy day with wind breeze. The weather temperature was 23 Celsius. The Barrett college courtyard is divided in two big grass areas with natural stones distributed all over the space. There are big trees providing shaded spots for students where student could lay under and read, study or socialize. The courtyard has also sitting areas around an outdoor fire place painted in yellow as well as other sitting areas with outdoor sofas. The smell of fresh air, the visualization of colorful natural elements and the sound of birds was also noted during observation. Several photographs were taken and analyzed as illustrated in Table (03-05A-C). The following biophilic elements and attributes were observed and summarized in Table (03-04).

Environmental features	Natural shapes and forms	Natural patterns and process
<ul style="list-style-type: none"> ▪ Color ▪ Air ▪ Sunlight ▪ Plants ▪ Animals ▪ Natural Materials ▪ View and vistas ▪ Geology and landscape ▪ Fire 	<ul style="list-style-type: none"> ▪ Botanical motifs ▪ Trees and columnar support ▪ Vaults ▪ Shapes resisting straight lines and right angles ▪ Simulation of natural features ▪ Tubular forms 	<ul style="list-style-type: none"> ▪ Bounded spaces ▪ Transitional spaces ▪ Dynamic balance and tension ▪ Hierarchically organized ratios and scales ▪ Complementary contrast ▪ Sensory variability
Light and space	Place based relationship	Evolved human -nature relationship
<ul style="list-style-type: none"> ▪ Natural Light ▪ Filtered and diffused light ▪ Warm light ▪ Light pools ▪ Light as shapes ▪ Spaciousness ▪ Light and shadows ▪ Reflected light ▪ Special variability ▪ Special harmony ▪ Inside-outside spaces 	<ul style="list-style-type: none"> ▪ Landscape orientation ▪ Landscape featured that defines building form ▪ Avoiding place-lessness ▪ Landscape ecology 	<ul style="list-style-type: none"> ▪ Prospect and refuge ▪ Order and complexity ▪ Security and protection ▪ Mastery and control ▪ Attraction and beauty

Table (03-04): Elements and Attributes from Location B



Location B pictures	Element and Attribute
	<p>Environmental features: ●</p> <ul style="list-style-type: none"> -Color -Plants -Fire -Natural materials (stones) <p>Natural shapes and forms: ●</p> <ul style="list-style-type: none"> -Tubular forms (the building structure)
	<p>Environmental features: ●</p> <ul style="list-style-type: none"> -View and vistas -Geology and landscape <p>Natural shapes and forms: ●</p> <ul style="list-style-type: none"> -Shapes resisting straight lines and right angles <p>Light and space: ●</p> <ul style="list-style-type: none"> Inside-outside spaces Spaciousness <p>Place based relationship: ●</p> <ul style="list-style-type: none"> -Landscape features that defines the building form -Landscape ecology

Table (03-05A): Analyzed Photographs of Location B



Location B pictures	Element and Attribute
	<p>Natural shapes and forms: ●</p> <ul style="list-style-type: none"> - Vaults <p>Natural patterns and process: ●</p> <ul style="list-style-type: none"> - Bounded spaces - Transitional spaces - Complementary contrast (light and dark, high and low)
	<p>Environmental features: ●</p> <ul style="list-style-type: none"> - Animal <p>Natural shapes and forms: ●</p> <ul style="list-style-type: none"> - Botanical motifs - Simulation of natural features <p>Place based relationship: ●</p> <ul style="list-style-type: none"> - Avoiding place-lessness

Table (03-05B): Analyzed Photographs of Location B

Location B pictures	Element and Attribute
	<p>Environmental features: ●</p> <ul style="list-style-type: none"> -Sunlight <p>Natural shapes and forms: ●</p> <ul style="list-style-type: none"> -Trees and columnar support <p>Light and space: ●</p> <ul style="list-style-type: none"> -Natural Light -Filtered and diffused light -Warm light -Light pools -Light as shapes -Light and shadows -Reflected light <p>Evolved human -nature relationship: ●</p> <ul style="list-style-type: none"> -Attraction and beauty
	<p>Natural patterns and process: ●</p> <ul style="list-style-type: none"> -Hierarchically organized ratios and scales -Dynamic balance and tension <p>Light and space: ●</p> <ul style="list-style-type: none"> -Special harmony -Special variability <p>Evolved human -nature relationship: ●</p> <ul style="list-style-type: none"> -Prospect and refuge -Order and complexity: forced presence of nature and structure with an amount of details -Security and protection -Mastery and control <p>Place based relationship: ●</p> <ul style="list-style-type: none"> - Landscape orientation

Table (03-05C): Analyzed Photographs of Location B

3.3 Research instrument

After observation phase, surveys were distributed among the students using the two courtyards. The total number of participants was 30 in each location. The surveys were collected during a sunny day of May 2019 from 12:00 PM to 3:00 PM.

The survey used in this paper to measure the level of satisfaction with educational experience is inspired from RESS scale used to evaluate the residential environmental satisfaction (Adriaanse 2007), and nature connectedness scale (Nisbet *et al*, 2009). The connectedness to nature scale (CNS) was proven to be a reliable empirical tool with good psychometric properties. This was due to a study conducted on a community and three different college samples (Mayer & Frantz 2004). The aim of this study is to reach as much questionnaire as possible per courtyard completed. The survey is used in the research over semi structured interviews for the possibility of obtaining more participants in a restricted timeframe.

The survey is designed to investigate if biophilic design affect student's educational satisfaction along with other questions that support the observation of the location. Students will first read a consent form including some information about the research (For the consent form see appendix C). The first two questions are about scholars' demographics, gender and age. Questions from 3 to10 are about their preferences using a 1 to 5 point Likert scale. Some of these questions were used to help determine the existence of some attributes in the first stage of observation. (For the survey questions, see appendix D).

3.4 Data collection and analysis

To assess students' reaction with nature this research requires a qualitative and quantitative approach. The quantitative approach will help in measuring the subjects'

satisfaction with the educational experience. methodologies help in shaping this research include a literature review to provide useful information backing up the research. Qualitative approach will help in understanding the meaning behind certain reaction from an individual or group towards a human or society problem as stated in research design reference (D. Creswell and J. Creswell, 2018).

To get more participants to this research, the questionnaire is used over the interview. A camera will be used to take pictures of both location A and B.

3.5 Strategies and approaches

This research is designed using basic methods and techniques that best serve the purpose of the study. The data collected from the different methods used in this proposal will be examined systematically to be included in the data base system. The literature review is used to understand the connection between humans and nature, to determine best measuring tools, and to provide information backing up the research. The research is divided into two sections based on the primary research questions as illustrated in Figure (03-03). The first section is to determine the best locations used for this research where the used method is observation. The second section answers the main questions of this research. The first step is to answer the first question is investigation the effectiveness of nature on students' satisfaction with educational experience and the second step is determining the improvements applied to the courtyard space to increase the students' satisfaction with education. The method used in both steps of the second section is survey to get the feedback from students to measure their satisfaction. It will allow the researcher to go deeply into students' thoughts and perceptions of their surroundings and how to improve it for the sake of their comfort.

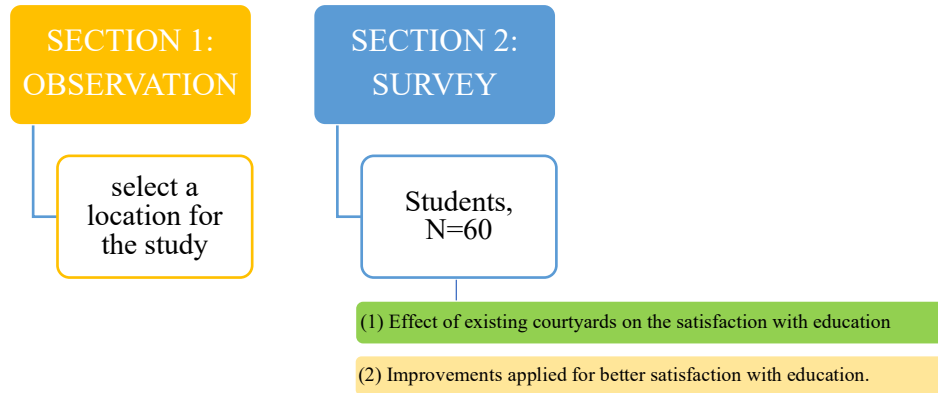


Figure (03-03)

The Research design: Two main sections and two methods used.

The data collected from the surveys filled by students will be evaluated and a detailed analysis of the results will be provided by visual media such as diagrams and charts. Based on the results from the surveys, a design guideline will be suggested to design the ideal courtyard environment for student's satisfaction.

CHAPTER 4

RESULTS

4.1 Results

This study explores how biophilic design affect students' satisfaction with education. More specially, in what ways does it influence how student's study and learn in universities? The other purpose of this research is to identify ways to enhance the student's environment at the external courtyards on campus within an educational setting to improve their experiences. To answer these two questions, a 15 questions survey was used to measure students' satisfaction.

The first two questions concern student's demographics: gender and age. Questions three through fifteen are about the student's experiences, preferences, and their opinions of the courtyard. The third and eighth questions ask about the preferred and the existing courtyards natural mix (landscape, light and shade, trees, plants and shrubs). Questions four, five, six, seven, twelve and thirteen are about students experience in relation to different factors within the courtyards; including weather, pleasure, inspirational factors, learning, safety and control. The questions nine, ten and fourteen, pertain to students' opinions and beliefs. Finally, questions eleven and fifteen measure students' total satisfaction as listed in Table (04-01).

Students were asked to assess their answers from 1 to 5; 1 strongly agree, 2 agree, 3 neutral, 4 disagree, and 5 strongly disagree. The last question about overall satisfaction used the descriptors; 1 very high, 2 high, 3 neutral, 4 low, and 5 very low. The questionnaire was distributed among two different location groups (McCord Hall and Barrett College). Regarding each group's responses, further results in the analysis are provided

Code	Question
1_ Gender	Gender
2_ Age	Age
B3_ Natural mix	I like the natural mix (landscape, light and shade, trees, plans and shrubs) of the courtyard space.
B4_ Weather	I enjoy being in this courtyard, even in unpleasant weather.
B5_ Annoying	Spending time in this courtyard is annoying.
B6_ Experience	I like my experience at the campus courtyard.
B7_ Inspiration	I feel inspired when I practice my activities in this courtyard.
B8_ Existing natural mix	I am happy with the existing natural elements in this courtyard.
B9_ Importance	I believe that this courtyard is very important to university campus life.
B10_ Nature connectedness	My connection to nature and the environment in this courtyard is a part of my educational life.
B11_ Satisfaction with studying	Courtyard has an effect on my satisfaction with studying within this university.
B12_ Safety & control	I feel safe and in control while being in this courtyard.
B13_ Learning process	My feelings about nature in this courtyard affect how I learn in this university.
B14_ Nature importance	I believe that natural elements (landscape, light and shade, plantation) are very important to be implemented in educational settings.
B15_ Level of satisfaction	Please rate the level of satisfaction with this courtyard.

Table (04-01): Survey questions

4.1.1 Data Analysis

Location A, McCord hall, is considered the location with less biophilic elements and attributed than the Location B, Barrett college, as presenter in Table (04-02).

Environmental features	Natural shapes and forms	Natural patterns and process
Water Air Sunlight Plants Animals Natural materials views	<ul style="list-style-type: none"> ▪ Botanical motifs ▪ Trees and columnar support Shapes resisting straight lines and right angles <ul style="list-style-type: none"> ▪ Tubular forms (the fountain) 	<ul style="list-style-type: none"> ▪ Sensory variability ▪ Central focal point ▪ Bounded spaces ▪ Transitional spaces Hierarchically organized ratios and scales
Light and space	Place based relationship	Evolved human -nature relationship
<ul style="list-style-type: none"> ▪ Natural Light ▪ Filtered and diffused light ▪ Light pools ▪ Reflected light ▪ Warm light ▪ Light as shapes ▪ Special harmony ▪ Light and shadows 	<ul style="list-style-type: none"> ▪ Avoiding placelessness 	<ul style="list-style-type: none"> ▪ Prospect and refuge ▪ Security and protection ▪ Mastery and control

Table (04-02): Elements and Attributes from Location A (McCord Hall)

The total respondents to the survey at McCord Hall was 30 where 53% of them were male and 46% were female as illustrated in Figure (04-01) below. The age ranged from 18 to 35 years old. In table 04 there are three variables presented as 1, 2, and 3 in the age table, which refers to the age group: 1, (18-25); 2, (26-30); and 3, (31- 35) years old.

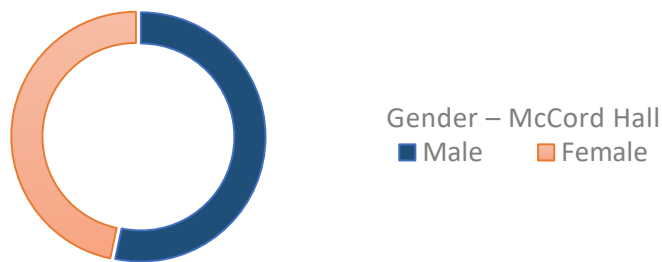


Figure (04-01): Gender – Location A McCord

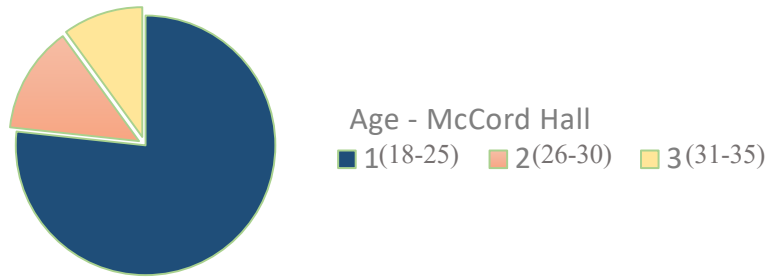


Figure (04-02): Age groups – Location A_McCord Hall

Barrett College has double the biophilic design attributes in McCord hall as listed in Table (04-03).

Environmental features	Natural shapes and forms	Natural patterns and process
<ul style="list-style-type: none"> ▪ Color ▪ Air ▪ Sunlight ▪ Plants ▪ Animals ▪ Natural Materials ▪ View and vistas ▪ Geology and landscape ▪ Fire 	<ul style="list-style-type: none"> ▪ Botanical motifs ▪ Trees and columnar support ▪ Vaults ▪ Shapes resisting straight lines and right angles ▪ Simulation of natural features ▪ Tubular forms 	<ul style="list-style-type: none"> ▪ Bounded spaces ▪ Transitional spaces ▪ Dynamic balance and tension ▪ Hierarchically organized ratios and scales ▪ Complementary contrast <p>Sensory variability</p>
Light and space	Place based relationship	Evolved human -nature relationship
<ul style="list-style-type: none"> ▪ Natural Light ▪ Filtered and diffused light ▪ Warm light ▪ Light pools ▪ Light as shapes ▪ Spaciousness ▪ Light and shadows ▪ Reflected light ▪ Special variability ▪ Special harmony ▪ Inside-outside spaces 	<ul style="list-style-type: none"> ▪ Landscape orientation ▪ Landscape featured that defines building form ▪ Avoiding place-lessness ▪ Landscape ecology 	<ul style="list-style-type: none"> ▪ Prospect and refuge ▪ Order and complexity ▪ Security and protection ▪ Mastery and control <p>Attraction and beauty</p>

Table (04-03): Elements and Attributes from location B (Barrett College)

Figure (04-03) illustrated bellow shows the percentage of male participants in the Barrette College location as 36.7% while female percentage was 63.3% which indicates that there are more female respondents than male. As for age, the pie chart in Figure (04-04) shows that all participants were between age 18 to 25 (age group 1).

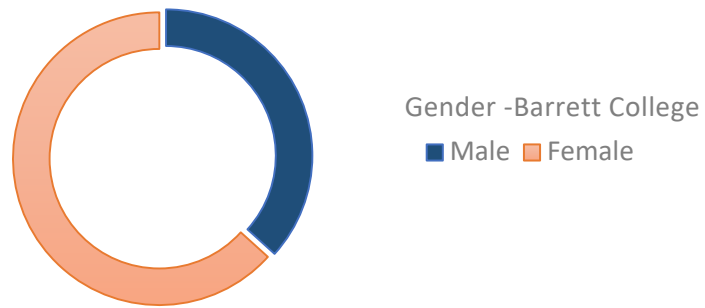


Figure (04-03): Gender – Location B_Barrett College

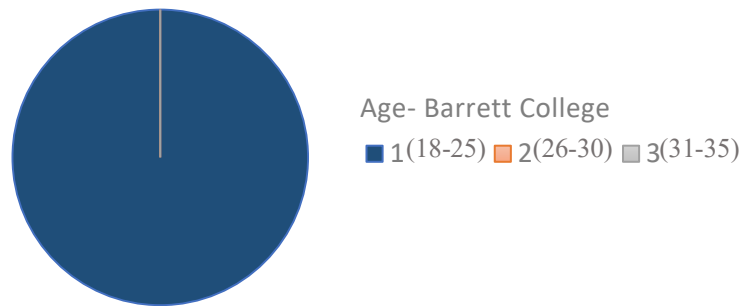


Figure (04-04): Age groups – Location B_Barrett College

Table (04-04) and Table (04-05) shows descriptive statistics for both locations A_McCord hall and B_Barrett college. The N column is for number of participants, the maximum and minimum columns represents the average of the highest and lowest scores in the Likert scale chosen by students and the means column stands for the average of students responses.

Looking at these two tables we can see that there are some meaningful results. At the first location, statistics shows B5_Annoyance mean as 3.73 while in the other location it is as high as 4.53 which means that students at the second location are not as annoyed as students at the first one. Looking at B4_weather, student at Barrett college enjoy spending time at the courtyard even when the weather is unpleasant with a mean of 2.23 while in the McCord hall the average of B4_weather is 3.30 which indicates that it is natural for students. It seems that Students at both locations are happy with the existing natural elements according to B8_existing natural elements as the average of location A is 2.80 while the mean of B8_existing natural elements at the second location is 1.77

Additionally, it looks like students in the both locations feel safe and in control according to B12_Safety and control as presented in both tables where Location A shows mean of 2.20 and Location B shows a mean of 1.80 with only a different of about 0.4 points in between. Looking at B15 of both locations, it seems that both locations represents equal means of 2.50 for the first and 1.60 for the second. This may indicate that students at the first location are 0.1 more satisfied than the students of the second location. These meaningful results are important to determine if students are satisfied with their education more in the first or the second location. Regression analysis was performed to answer the research questions.

Descriptive :

	N	Minimum	Maximum	Mean	Std. Deviation
B3_Natural elements	30	1	5	2.03	1.0
B4_Weather	30	2	5	3.30	1.0
B5_Annoyance	30	1	5	3.73	1.0
B6_Courtyard experience	30	1	5	2.33	1.1
B7_Inspiration	30	1	5	2.93	.9
B8_Existing natural elements	30	1	5	2.80	1.1
B9_Importance	30	1	5	2.30	1.1
B10_Nature connectedness	30	1	5	2.80	1.0
B11_satisfaction with studying	30	1	5	2.70	.9
B12_Safety and control	30	1	5	2.20	.8
B13_Learning process	30	1	5	3.10	1.1
B14_Nature importance	30	1	3	1.80	.7
B15_Level of satisfaction	30	1	5	2.50	1.0
Valid N (listwise)	30				1.0

Table (04-04): Descriptive Statistics of Location A_McCord Hall

	N	Minimum	Maximum	Mean	Std. Deviation
B3_Natural elements	30	1	3	1.37	.6
B4_Weather	30	1	5	2.23	1.1
B5_Annoyance	30	3	5	4.53	.6
B6_Courtyard experience	30	1	3	1.60	.6
B7_Inspiration	30	1	4	2.40	.9
B8_Existing natural elements	30	1	3	1.77	.6
B9_Importance	30	1	4	1.93	.9
B10_Nature connectedness	30	1	4	2.57	1.0
B11_satisfaction with studying	30	1	4	2.30	1.0
B12_Safety and control	30	1	3	1.80	.6
B13_Learning process	30	2	4	2.73	.8
B14_Nature importance	30	1	4	1.60	.8
B15_Level of satisfaction	30	1	2	1.60	.5
Valid N (listwise)	30				

Table (04-05): Descriptive Statistics of Location B_Barrett College

4.1.2 Regression Analysis

The purpose of the regression analysis is to help answer the two main question; (1) How do existing courtyards contributes to the satisfaction of educational experience of students in universities? (2) What are the improvements that should be applied to the educational establishments' courtyards to enhance students' satisfaction with educational experience? To gain a better understanding, a regression analysis is conducted on B6_Courtyard experience, B11_ Satisfaction with studying and B15_ Overall satisfaction considering these questions as dependable variables. The chosen independent variables will be: B3_Nature, B4_weather, B7_inspiration, B8_Existing natural elements and B12_safety and control as illustrated in Figure (04-05). The independent variables were chosen due to the significance it gives to the study results. This analysis will be carried out in both locations separately and then combined.

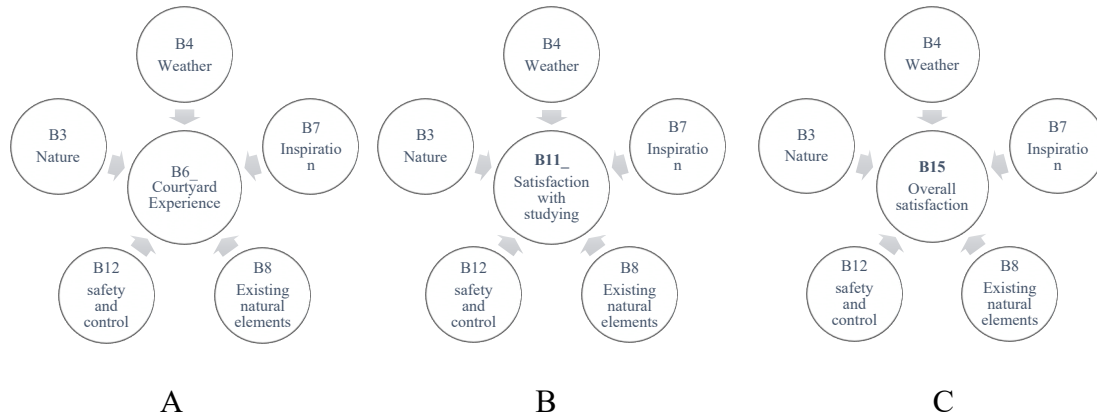


Figure (04-05): (A)B6_courtyard experience as dependent variable diagram in relation to the independent variables. (B) B11_satisfaction with studying as dependent variable diagram in relation to the independent variables. (C)B15_Level of satisfaction as dependent variable diagram in relation to the independent variables.

4.1.3 Location A: McCord hall

Table (04-06) represents the B6_experience as a dependent variable for Location A. As we can see, there is no relation to any of the independent variables.

B6_Courtyard experience						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.1	1.50		1.4	.16
	B3_Natural elements	-.15	.26	-.14	-.6	.56
	B4_weather	-.06	.21	-.05	-.3	.79
	B7_Inspiration	.22	.25	.20	.89	.38
	B8_Existing natural elements	.12	.28	.12	.40	.68
	B12_safety and control	-.05	.30	-.04	-.16	.87

Table (04-06): Dependent Variable: B6– Location A

B11_satisfaction with studying, is the dependent variable in Table (04-07). As displayed, there is no indication of any significant relation between B11 and any other variable in the Location A.

B11_Satisfaction with studying						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.13	1.54		.08	.93
	B3_Natural elements	-.09	.25	-.09	-.35	.72
	B4_weather	.12	.20	.12	.57	.57
	B7_Inspiration	.19	.24	.20	.80	.43
	B8_Existing natural elements	-.32	.27	-.37	-1.20	.24
	B12_safety and control	.13	.3	.13	.47	.64

Table (04-07): Dependent Variable: B11– Location A

As B_15 overall satisfaction is a dependent variable in Table (04-08), there is more than one significant relation noted with. B3_ natural mis (0.003), B8_ existing natural elements (0.003) and B12_ safety and control (0.020).

B15_ level of Satisfaction						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.23	.85		.27	.78
	B3_ Natural elements	.37	.10	.34	3.43	.003
	B4_ weather	.07	.12	.06	.64	.52
	B7_ Inspiration	.02	.13	.02	.17	.86
	B8_ Existing natural elements	.41	.11	.42	3.45	.003
	B12_ safety and control	.35	.14	.29	2.57	.020

Table (04-08): Dependent Variable: B15– Location A

4.1.4 Location B: Barrett College

Table (04-09) of the Barrett location shows no significant with any of the independent variables.

B6_ Courtyard experience						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.58	1.41		1.11	.28
	B3_ Natural elements	-.26	.25	-.25	-1.03	.31
	B4_ weather	.14	.10	.27	1.38	.18
	B7_ Inspiration	.19	.14	.28	1.32	.20
	B8_ Existing natural elements	-.05	.19	-.06	-.29	.77
	B12_ safety and control	-.30	.27	-.29	-1.09	.28

Table (04-09): Dependent Variable: B6– Location B

As displayed in Table (04-10), there is a reported significance of 0.037 between B11 and B7_ inspiration.

B11_Satisfaction with studying						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.05	2.29		1.76	.09
	B3_Natural elements	-.57	.41	-.33	-1.35	.19
	B4_weather	.04	.18	.05	.24	.80
	B7_Inspiration	.51	.22	.46	2.26	.037
	B8_Existing natural elements	-.04	.32	-.02	-.13	.89
	B12_safety and control	-.04	.49	-.02	-.08	.93

Table (04-10): Dependent Variable: B11-Location B

A relation of significance of 0.002 was also noted between B15 and B3_Natural mix in Table (04-11)

B15_level of Satisfaction						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.13	1		-1.14	.27
	B3_Natural elements	.5	.14	.55	3.55	.002
	B4_weather	-.12	.07	-.26	-1.72	.10
	B7_Inspiration	-.13	.10	-.23	-1.32	.20
	B8_Existing natural elements	.21	.13	.26	1.7	.11
	B12_safety and control	.2	.2	.20	1	.36

Table (04-11): Dependent Variable: B15- Location B

4.1.5 Location A and B Combined:

Table (04-12) shows an average significant relation of 0.045 between B6_courtyard experience and B7_Inspiration

B6_Courtyard experience						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.87	.87		1.00	.32
	B3_Natural elements	-.01	.14	-.016	-.12	.1
	B4_weather	.02	.1	.036	.3	.76
	B7_Inspiration	.26	.12	.264	2.06	.045
	B8_Existing natural elements	.13	.16	.152	.85	.39
	B12_safety and control	.01	.2	.007	.04	.96

Table (04-12): Dependent Variable: B6_Courtyard experience

Table (04-13) shows an average relation of 0.016 between B11_students satisfaction with education and B7_inspiration.

B11_satisfaction with studying						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.06	1.02		1.04	.30
	B3_Natural elements	-.12	.16	-.11	-.73	.47
	B4_weather	.09	.11	.11	.83	.40
	B7_Inspiration	.36	.14	.36	2.51	.016
	B8_Existing natural elements	-.23	.2	-.24	-1.22	.23
	B12_safety and control	.1	.20	.06	.39	.69

Table (04-13): Dependent Variable: B11_satisfaction with education

In Table (04-14) The analysis shows significance between B15 and B3_natural mix with 0.000. B15 is also strongly related to B8_existing natural mix. In addition, there is a relation of significance between B15 and B12_safety and control that is considered an attribute of biophilic design under Involved human -nature relationship element (Kellert 2008)

B15_Level of satisfaction						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.6	.6		1	.33
	B3_Natural elements	.33	.1	.31	4.02	.000
	B4_weather	-.05	.06	-.06	-.81	.42
	B7_Inspiration	-.02	.1	-.02	-.3	.76
	B8_Existing natural elements	.43	.1	.47	4.93	.000
	B12_safety and control	.37	.10	.3	3.58	.001

Table (04-14): Dependent Variable: B15_Level of satisfaction

Figure (04-06) below illustrates the sum of the three variables (three depv) B6_Courtyard experience, B11_satisfaction with studying and B15_Level of satisfaction of students responses. As we can see, the McCord Hall showed higher results comparing to the Barrett College. The central lines of both bars represent average of students answers to the survey and the two lines extended both ways for the bar indicated the error range, it could possibly go as high as 13 for McCord or down to 3. Similarly, it could go as high as 8 for Barrett College or as low as 3.

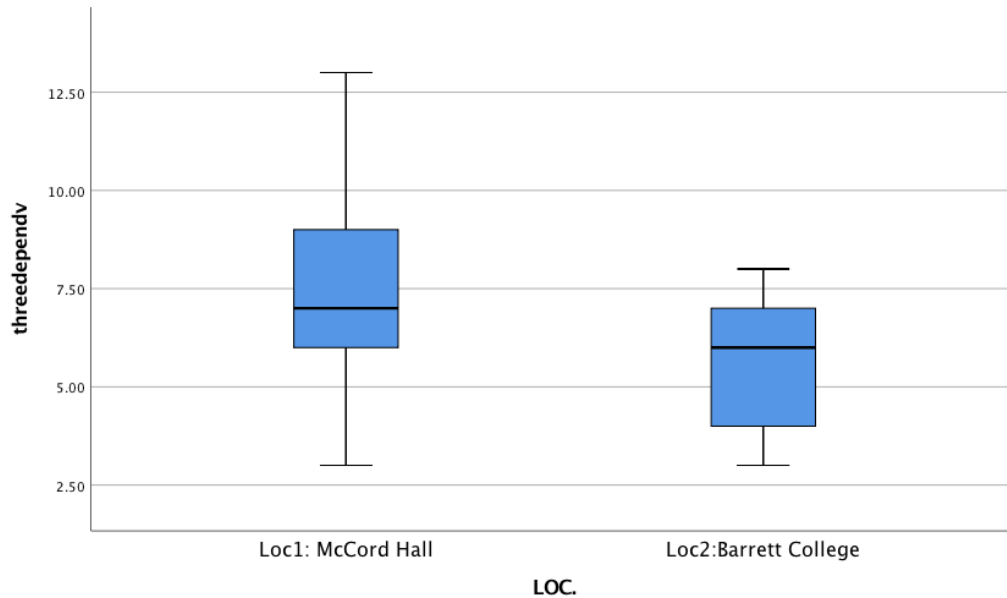


Figure (04-06): Ratio of B6, B11 and B15 in Location A and B.

4.1.6 Data normality test:

During the analysis, overall data normality was tested for both location and found reasonable as Q-Q plot illustrates in Figure (04 -07A-B). The goal of this test is to see if the curves in both locations are regular. In this test, the dots represent the observed data as the solid line indicates the expected data. As shown in McCord hall normality test in Figure (04-07A), the dots meet with the line and the average of 7.5 meets with the zero of expected data on the Z axis. In contrast, the Barrett college average should be between 4 and 6 which indicates that it does not meet with the zero in the expected data although the observed value is close to the expected in Figure (04- 07B)

Further regression model based on the location was introduced and found that there is a significant indicator other than gender and age effecting the data collected as shown in Figure (04-10A-B). The goal of this test is to see if the curves in both locations are regular.

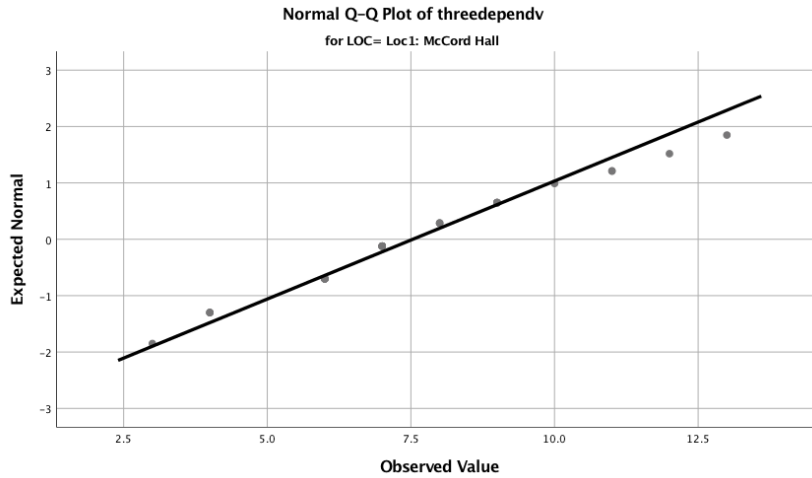


Figure (04-07A): Data normality test for McCord hall

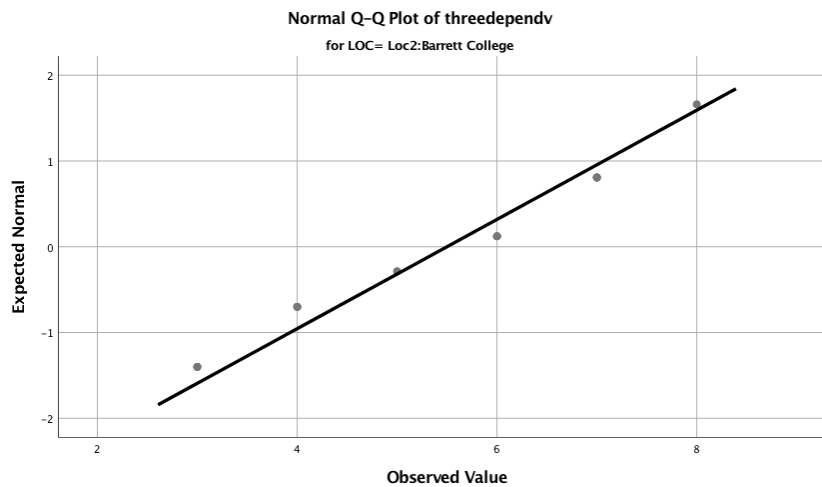


Figure (04-07B): Data normality test for Barrett College

After data normality tested, a histogram is made to find if there is any effect influencing the data pulled from both locations. As Figure (04-08A) illustrates, the average of the students' responses in McCord Hall is in the peak which produces a good curve even though there is up normality in the results. In Figure (04-08B) we can see that the average of students' response is not in the peak which illustrates a not normal curve with two peaks.

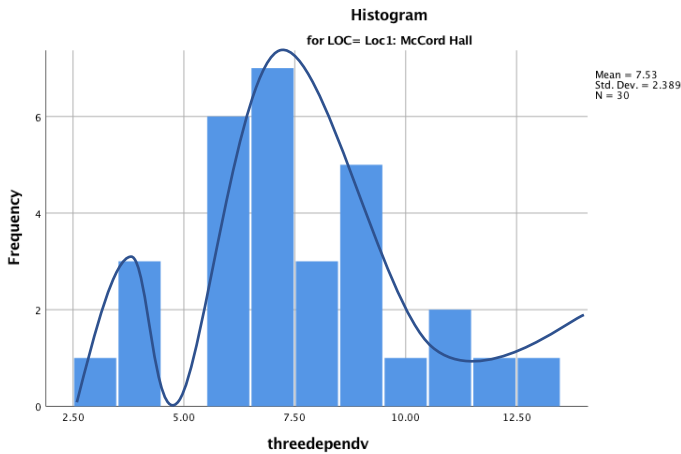


Figure (04-08A): Ratio B6,B11,B15 Dependent variables at McCord Hall

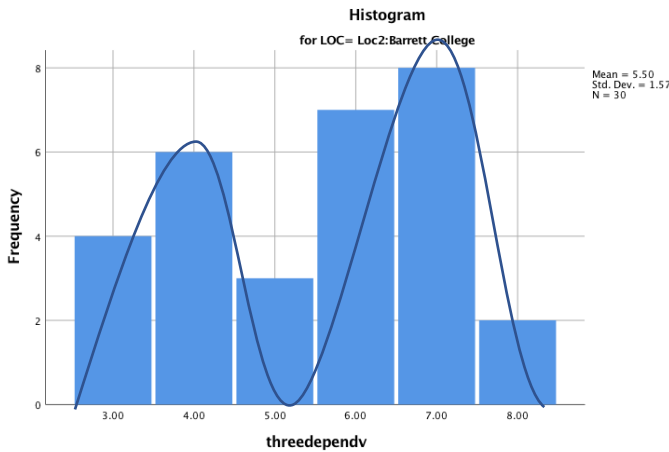


Figure (04-08B): Ratio B6,B11,B15 Dependent variables at Barrett College

No significance relationship between the three variables B6_courtyard experience, B11_Satisfaction with studying and B_15 level of satisfaction and age or gender as Table (04-16) shows.

B6_B11_B15						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.424	.904		7.104	.000
	AGE	.387	.612	.085	.632	.530
	GENDER	-.653	.602	-.146	-1.085	.282

Table (04-16): Dependent Variable: B6_courtyard experience, B11_Satisfaction with studying, B_15 level of satisfaction.

4.1.7 Summary of dependent variables findings:

The following Table (04-17) highlights the finding of each location separately and combines.

Location A:	Location B:	Combined locations:
<ul style="list-style-type: none"> • Students overall satisfaction depends on: <ol style="list-style-type: none"> 1. their perception of nature elements. 2. The existing element of nature in the courtyards. 3. Their feeling of safety and control. • Students belief of the importance of the nature in the courtyard depends on the natural of the space 	<ul style="list-style-type: none"> • Students satisfaction with studying depends on their feeling of inspiration. • Students overall satisfaction depends on Their perception of natural elements. • Students belief of the importance of the nature in the courtyard depends on their feeling of safety and control 	<ul style="list-style-type: none"> • Students courtyard experience and satisfaction with studying depends on their feeling of inspiration. • Students overall satisfaction depends on: <ol style="list-style-type: none"> 1. their perception of nature elements. 2. The existing element of nature in the courtyards. 3. Their feeling of safety and control.

Table (04-17): Summary of independent variables regression.

CHAPTER 5

DISCUSSION

5.1 General discussion

This paper discusses the biophilic design elements, attributes and the effect they cause to students' satisfaction with educational and the possible developments implemented in the outdoor environment to ensure a better experience in the educational establishment. The method used was a survey handout distributed among students in two different locations within Arizona State University where each location was observed for biophilic elements and attributes based on the Elements and Attributes of Biophilic Design (Kellert 2008).

To answer the first question of how the elements and attributes of biophilic design affect student do satisfaction with education, the results indicates that it has a positive effect on student satisfaction with education. However, it does not necessarily mean that areas with higher elements and attributes have a greater impact than the courtyard with fewer elements and attributes.

As data results show, neither age nor gender has an effect on the data collected even though more than one age group participated in the first location, McCord hall, comparing to the second location, Barrett college. On the other hand, the regression analysis based on location showing significance to the 5 tested variables; B3_ Natural, B4_ weather elements, B7_ Inspiration, B8_ Existing natural elements and B12_ safety and control, which indicates that there is an impact on the positive influence both courtyards have on student's satisfaction with education. Up to this point, the data analysis made does not identify if this influence is the result of a special kind of population or any other indicator, but this could

be a separate research question. In conclusion, we cannot say for sure if the Barrett location’s biophilic elements and attributes do not affect student educational satisfaction as much as McCord hall until we have found what is causing their responses to be somehow not normal compared to the first location.

5.2 Conceptual framework

Applying biophilia in the campus courtyard will allow students to reconnect with nature. As presented in Puri, 2016, perceiving nature reduces stress and enhances productivity. In return, stress is negatively correlated with student satisfaction of educational experience (Puri 2016). This section is made to state the relationship between variables based on this paper’s result analysis. The overlapping relationship between biophilia and courtyard spaces results in an incorporation of nature in courtyards. Biophilic courtyards improves student satisfaction with education. The results of this research indicate that biophilic principles can be used to create guidelines to keep students satisfied as illustrated in Figure (05-01).

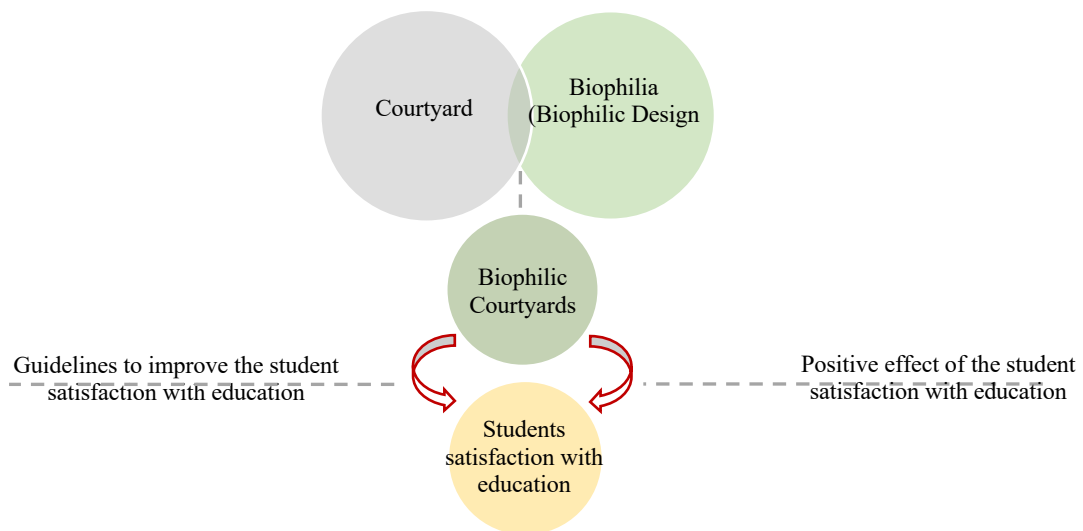


Figure (05-01): Conceptual framework

5.3 Recommendations

Biophilic design along with its elements and attributes is considered an important area of research since it re-evaluates the bond between humankind and nature. This bond is especially important because it was found to be positive on many levels such as health, well-being and stress reduction. In this paper, some guidelines were interpreted based on the observation phase, data analysis and the element and attributes of biophilic design to enhance student's satisfaction with education including:

- Natural Mix: Students in both locations show positive response to natural mixes, which include shrubs, plants, trees, landscape, light and shades in the courtyards. This means that students prefer a space with natural elements which supports this paper.
- Inspiration Stimulators which refer to the process of stimulating the mind to create, think or practice creativity. As the data results indicate, inspiration seems to be a significant component of students educational life. Few researches existed to determine the factors help inspire students. The closest study to this matter is the one presented by Oppezzo and Schwartz (2014). According to their study, walking helps with improving creativity (Oppezzo and Schwartz 2014). Another research conducted several studies about nature connectedness and cognitive thinking and creativity (Leong 2017). Results indicated that students with more exposure to nature showed positive response towards creative thinking. A third research in this matter involves two groups to explores the role of wilderness as a source of spiritual inspiration (Fredrickson and Anderson 1999). Results shows participants were spiritually inspired by the different landscape experiences.

- Weather Control and Treatments: Students tend to enjoy their time outdoors in courtyards with more biophilic designs and elements even if the inclement weather, as shown in the data analysis. What we conclude from this paper that there might be some attributes of biophilic design helping students in spending time outdoor in unpleasant weather conditions.

Each of these guidelines should be tested separately to find more about.

5.4 General conclusion

Biophilia, university courtyard and student educational satisfaction were examined in this study to see what kind of relationship they have with each other. As mentioned in an earlier section, nature reduces stress and improves productivity (Ryan *et al*, 2014), but what does it do to student satisfaction? How can biophilic courtyards improve students' satisfaction with their educational life?

This paper discusses the effect of Biophilic design elements and attributes on student satisfaction with education. First, an observation phase took a place at the campus to locate two courtyards – one with more elements and attributes than the other- to see what difference they made on students' life. Then, 60 students in total were surveyed in both locations. After a regression analysis made using the SPSS program, the results indicated a positive impact of biophilia on students' satisfaction. The results also showed that students in both locations reacted differently to the elements and attributes of biophilia. Students in McCord Hall reported a higher satisfaction than students in Barrett college, although the Barrett college recorded higher elements and attributes of biophilia. This could be due to the diversity of McCord Hall's sample compared to Barrett's sample. In addition, a data normality test showed abnormal data results in both locations, especially

at the Barrett College, which means that there is an indicator influencing the data collected from Barrett college. More research is needed to study student background, educational experience and expectations, and different cohorts to find out more about this indicator. Moreover, this study did not test the suggested improvements on students; therefore, more research should be implemented to see how effective these improvements could be. One considered limitation of this study is that no courtyard within Arizona State University seemed to be non-biophilic, which gives us nothing about the effect of empty courtyards on students satisfaction, but this could be tested in future research. In addition, having a larger sample of students will give extra reliability of the data in future studies.

The overall outcomes of the positive impact of biophilia on students in this research was expected; however, the differences between the two courtyards was not anticipated. In the light of this paper, we know how important biophilic designs are on students' educational life, stress, health and well-being. Once we make sure the ways nature affects us, we will work harder to keep it, incorporate it, preserve it and most importantly teach others how significant it is to our lives.

“It should also be noted that the more interaction there is with nature, the more stewardship of nature will follow to protect and contribute to the synergic domains of life, as is suggested by the Biophilia Hypothesis”
(Orman *et al*, 2017, p.116).

5.5 Consideration for future studies

This part lists suggested studies to be done in this field using some of the research limitations as well as other thoughts and ideas.

- Similar research to this study with enlarged sample sizes.
- A study to discover what affects students' perception of nature.
- More research to find how well students connect and benefit from nature.
- A study to discover if a particular elements or attributes of biophilia is more effective than others.
- A future study could find a courtyard with no biophilic design treatment to test it for student satisfaction.
- Testing the suggested guidelines in this paper and what is possibly supporting them.
- Future studies for more details about the guidelines in this paper to enhance students' educational life.
- Similar research in different countries, regions or climate.

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FOOTNOTE

Table (04-06) represents significant meanings of the regression analysis coefficients (Field 2018):

Model		Dependent Variable				
		Unstandardized Coefficients		Standardized Coefficients	4 t	5 Sig.
		1 B	2 Std. Error	3 Beta		
1	Independent Variable	2.1	1.50		1.4	.16

1. Unstandardized Coefficients B: it is the regression equation; For every unit increase in the independent variable, the dependent variable will increase by 2.1 as represented in the table below.
2. Unstandardized Coefficients Std. Error: This Coefficients measures the observation variation around the calculated regression line of the B coefficient.
3. Standardized Coefficients Beta: a measure of how strongly each independent variable influences the dependent variable. (the greater the beta, the more significance it gives)
4. t value: the t value measures the difference size relative to the variation in data the sample. $t \text{ value} = B / \text{St. Error}$
5. Sig: Or significance, is how strong is the relation between the independent and dependent variable. (less than 0.05 is considered significant)

Table (04-06): Regression Analysis Coefficients.

APPENDIX A
OBSERVATION NOTES OF LOCATION A

McCord Hall
2nd loc.

Friday
Monday Conclusion 15

TABLE 1-1 Elements and Attributes of Biophilic Design

Environmental features	Natural shapes and forms	Natural patterns and processes
Color ✓	Botanical motifs ✓ leaf and trees.	Sensory variability ✓ Smell
Water ✓	Tree and columnar supports ✓ one only.	Information richness
Air ✓ fresh air	Animal (mainly vertebrate) motifs	Age, change, and the patina of time
Sunlight ✓	Shells and spirals	Growth and efflorescence
Plants ✓	Egg, oval, and tubular forms	Central focal point ✓ water fountain
Animals ✓ Birds/leaves	Arches, vaults, domes	Patterned wholes
Natural materials ✓ Stones in fountain	Shapes resisting straight lines and right angles ✓ the design.	Bounded spaces ✓ curve on the floor
Views and vistas ✓ open view	Simulation of natural features ✓ Not	Transitional spaces ✓ Curve on
Facade greening	Biomorphy	Linked series and chains
Geology and landscape	Geomorphology	Integration of parts to wholes
Habitats and ecosystems	Biomimicry	Complementary contrasts
Fire		Dynamic balance and tension
		Fractals
		Hierarchically organized ratios and scales ✓ Shapes sitting ones
Light and space	Place-based relationships	Evolved human-nature relationships
Natural light ✓ sky/sun	Geographic connection to place	Prospect and refuge ✓ sheltered spaces.
Filtered and diffused light ✓ through trees	Historic connection to place	Order and complexity
Light and shadow ✓ trees/Birds.	Ecological connection to place ✓	Curiosity and enticement
Reflected light ✓ water/glass	Cultural connection to place	Change and metamorphosis
Light pools ✓ trees	Indigenous materials ✓	Security and protection ✓
Warm light	Landscape orientation	Mastery and control ✓
Light as shape and form ✓	Landscape features that define building form ✓	Affection and attachment
Spaciousness	Landscape ecology	Attraction and beauty
Spatial variability ✓	Integration of culture and ecology	Exploration and discovery
Space as shape and form	Spirit of place	Information and cognition
Spatial harmony ✓	Avoiding placelessness ✓	Fear and awe
Inside-outside spaces		Reverence and spirituality

Sunny day
- the building shades the half of the courtyard
it is 25°/23°
Not much of birds sounds

- Students mostly pass by.
or sit for few min.
? eat & wait for a class
Class break.
- People usually sit inside
with a view to the courtyard.
bicycles.

Location A observation notes.

APPENDIX B
OBSERVATION NOTES OF LOCATION B

Friday Wednesday

2nd loc -
Barrett College

TABLE 1-1 Elements and Attributes of Biophilic Design

Environmental features	Natural shapes and forms	Natural patterns and processes
Color → flowers and building structure	Botanical motifs leaf, tree shadow	Sensory variability smell, sight, sound
Water	Tree and columnar supports	Information richness
Air fresh air	Animal (mainly vertebrate) motifs	Age, change, and the patina of time
Sunlight and sky light	Shells and spirals	Growth and efflorescence
Plants grass, flowers, trees	Egg, oval, and circular forms	Patterned wholes the former / not central.
Animals birds	Arches, vaulted domes	Patterned wholes
Natural materials stone	Shapes resisting straight lines and right angles Curve lines	Bounded spaces
Views and vistas open space w/ view	Simulation of natural features Hills	Transitional spaces
Facade greening	Biomorphy	Linked series and chains
Geology and landscape park like courtyard	Geomorphology	Integration of parts to wholes high/low
Habitats and ecosystems	Biomimicry	Complementary contrasts Dark/light
Fire		Dynamic balance and tension
		Fractals
		Hierarchically organized ratios and scales Steps
Light and space	Place-based relationships	Evolved human-nature relationships
Natural light	Geographic connection to place different geographies	Prospect and refuge: places of protection
Filtered and diffused light through trees	Historic connection to place	Order and complexity
Light and shadow	Ecological connection to place	Curiosity and enticement
Reflected light out of surfaces.	Cultural connection to place	Change and metamorphosis
Light pools trees.	Indigenous materials	Security and protection
Warm light	Landscape orientation	Mastery and control
Light as shape and form botanical motifs	Landscape features that define building form all around the courtyard	Affection and attachment
Spaciousness huge	Landscape ecology	Attraction and beauty view/landscape
Spatial variability variety of spaces	Integration of culture and ecology	Exploration and discovery
Space as shape and form	Spirit of place	Information and cognition
Spatial harmony	Working placelessness	Fear and awe
Inside outside spaces at/in		Reverence and spirituality

• Sunny Day
 • Natural light
 • Wind Breeze / Fresh air
 • Birds everywhere
 • tight entrances caused the air to circulate at the courtyard.
 • shaded areas [tables and chairs]
 • trees / Big and small

• Students everywhere -
 1. laying down under trees
 2. relaxing
 3. reading
 4. talking.
 it is 23° / 28°
 bicycles
 Central axis thru the park.

Location B observation notes.

APPENIX C
SHORT CONSENT

STUDY TITLE: Biophilia and Education: analyzing the principles of courtyards in university settings through the lenses of biophilic design.

I am a graduate student under the direction of Professor Lori Brunner in the College of Design at Arizona State University. I am conducting a research study to investigate the effect of university courtyard on the scholars' satisfaction with education. Furthermore, research results will provide enough information to help improve universities' courtyards. I am inviting your participation, which will involve answering some questions about the courtyard you are visiting, the survey will take no more than five minutes to answer. You have the right not to answer any question, and to stop participation at any time. There are no foreseeable risks or discomforts to your participation

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. It will not affect your grade or credits. To participate in this study, you have to be 18 years old or older. Although there is no benefit to you from participating, possible benefits of your participation is to investigate the importance of courtyards in school settings. Your responses will be anonymous. The results of this study may be used in reports, presentations, publications but your name will not be used.

If you have any questions concerning the research study, please contact the research team at:

1. Lori Brunner (lori.brunner@asu.edu)
2. Rawan Naseef (Rnaseef@asu.edu)

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788. Please let me know if you wish to be part of the study. If you agree to participate in this study, turn in the survey.

APPENDIX D
SURVEY QUESTIONS

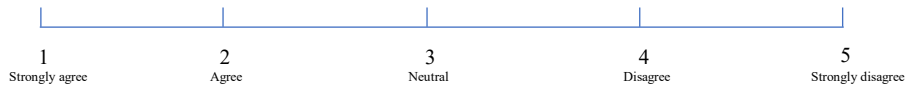
A. Please provide us with the following demographic information:

1. Gender:
 - a) Male
 - b) female
 - c) other
 - d) I'd rather not to say

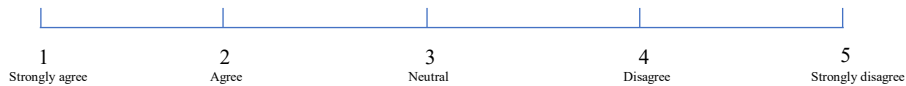
2. Age:
 - a) 18-25
 - b) 26-30
 - c) 31- 35
 - d) 36-40

B. On a scale from 1 to 5 where 1 is strongly agree and 5 is strongly disagree, answer the following questions.

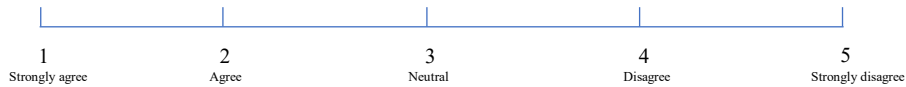
3. I like the natural mix (landscape, light and shade, trees, plants and shrubs) of the courtyard space



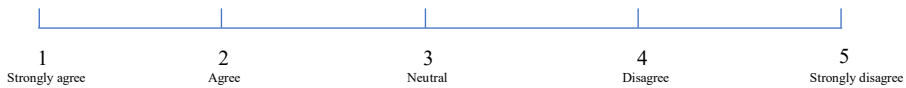
4. I enjoy being in this courtyard, even in unpleasant weather



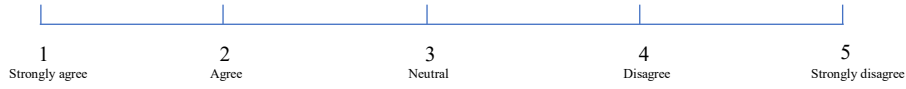
5. Spending time in this courtyard is annoying



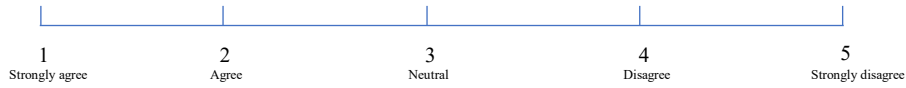
6. I like my experience at the campus courtyard.



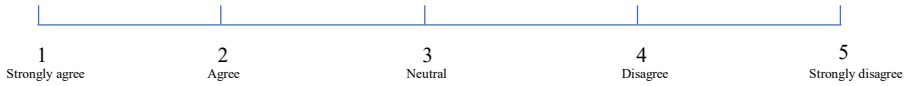
7. I feel inspired when I practice my activities in this courtyard



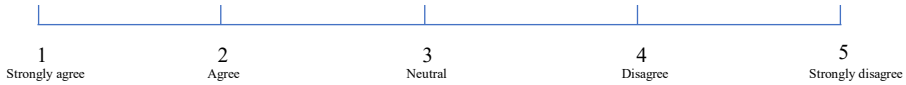
8. I am happy with the existing natural elements in this courtyard.



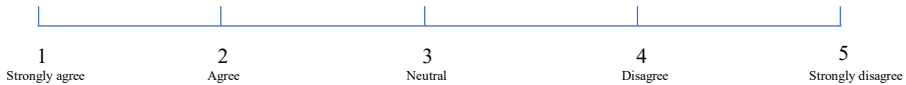
9. I believe that this courtyard is very important to university campus life



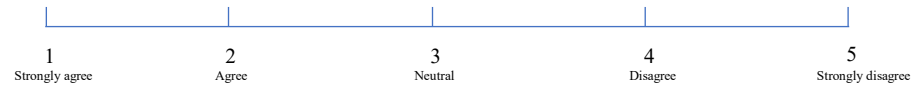
10. My connection to nature and the environment in this courtyard is a part of my educational life



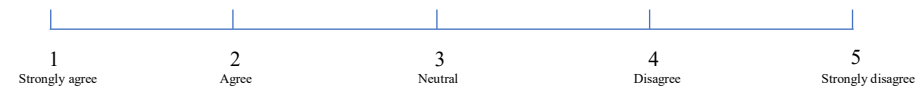
11. Courtyard has an effect on my satisfaction with studying within this university



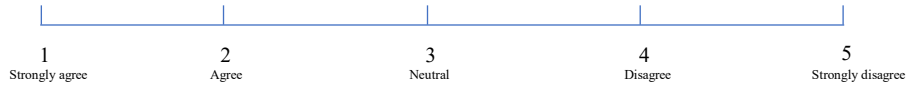
12. I feel safe and in control while being in this courtyard.



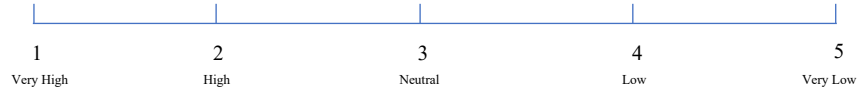
13. My feelings about nature in this courtyard affect how I learn in this university



14. I believe that natural elements (landscape, light and shade, plantation) are very important to be implemented in educational settings



15. Please rate the level of satisfaction with this courtyard.



Thank you for participation