ASSESSING THE PERCEPTION OF CAMPUS GREEN SPACE AND STRESS LEVELS AMONG STUDENTS AT MICHIGAN STATE UNIVERSITY

By

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ABSTRACT

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Previous studies found the use of natural green spaces to have positive effects on human health and wellbeing. Although a large number of studies have evaluated the perceived restorativeness of public urban green spaces, not many have investigated the effects in the university setting. This study assesses the perception of campus green space in relation to the stress levels of students. Quantitative and qualitative data was collected through a 2-part survey using questionnaires and a visual quality assessment on 20 images of Michigan State University's campus. For the visual quality assessment, students ranked 20 images from least stressful to most stressful. Results indicate that students prefer images with more green features when compared with less green images. Images with water features were also found to be perceived as less stressful. The findings of this study will assist designers in designing campus spaces for diverse populations as well as providing features that will promote health and wellness.

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Chapter 1. Introduction

According to the World Health Organization (WHO, n.d.), 54% of the total population lived in urban areas in 2014 and the number is expected to grow 1.84% between 2015 and 2020. Population increases in urban areas significantly impacts environmental and human health (WHO, n.d.). Specific issues such as air pollution, flooding, and the spread of toxic substances have become prominent, but they can be combated through the implementation of urban green spaces such as parks, trails, open fields, streams, or even plaza spaces (WHO, n.d.). These urban green environments have the potential to become highly valued spaces because of their ability to provide unique experiences not readily available in urban cities (Ulrich, 1979). Although the need for urban green environments is a growing trend in many developed countries, the implementation and planning of green spaces are often the last part of the design phase. Researchers continue to support the significance of green spaces and future data will help to link professionals such as policy makers, planners, engineers, and landscape architects together to implement urban green spaces in the early stages of design.

Chapter 2. Literature Review

There is overwhelming literature on the role of green space in numerous disciplinary fields, including psychology, planning and design, economics, ecology, sociology, criminology, and public health (Burley, Deyoung, Partin, & Rokos, 2011; Kaplan & Kaplan, 1989; Nassauer, Wang, & Dayrell, 2009; Van den Berg, Maas, Verheij, & Groenewegen, 2010). For this research, the literature reviewed is structured around i) factors that influence green space preference and green space use, and ii) the benefits of green space with a particular focus on stress reduction. The literature focuses on demographic considerations and the physical spatial elements with regard to the factors that influence green space preference and use. In reviewing the benefits of green space, this study narrows in on stress reduction as a benefit.

2.1 Factors that Influence Preference and Use

2.1.1 Demographic

It is fundamental to identify how a space is used in order to produce a well-designed space. Although there may be a general consensus on the types of activities or reasons people use a space, there are many background factors that may affect why people choose to use a space. Researchers have found that urban green space can have an effect on the users' behavior (Lo & Jim, 2012). Qualitative and quantitative surveys are effective methods to gather data on the socioeconomic factors that influence the use of green spaces. Socioeconomic factors like income, age, and location are significant in determining the different uses according to the needs of the users (Lo & Jim, 2012). Researchers have found that lower income and lower education levels had significant impacts on green spaces (Lo & Jim, 2012; Maas et al., 2006). However, this may be because wealthier people tend to live in areas of private housing with high security. Since

lower income neighborhoods may not have as many security measures, the lower income populations tend to base use off of their concern for safety (Lo & Jim, 2012).

Variations of preference will also occur based on how familiar the user is of the environment (Kaplan & Kaplan, 1989). For example, if a suburban area was designed to drastically re-develop in order to attract tourists, the local residents may have a lower preference for the new environment. A visitor, on the other hand, may have a higher preference for the new environment if viewing it is aesthetically pleasing. People who live in urban environments are generally more concerned with levels of safety within community parks. Previous studies have found the perception of naturalistic green spaces while others have looked at the perception of urban green spaces. Through the study findings, factors such as type of vegetation and park location were found to vary between people of different geographical backgrounds. Wild looking vegetation may not be as aesthetically pleasing to residents who were used to seeing more manicured landscape designs (Yang, Li, Elder, & Wang, 2013).

Another factor that can strongly influence an individual's preference for green space use is culture. Culture differs throughout the world but it is a factor that brings people within a similar geographic region together through shared similar experiences (Kaplan & Kaplan, 1989). People who share the same culture will likely have lived in the same location, which means the vegetation they have seen will be familiar. The landscape style that may exist in one culture shapes the mindset of the groups and unconsciously develops what is right and wrong in the design.

2.1.2 Spatial (Design) Elements

Finding preferred design elements can help urban planners and landscape architects to produce better, efficient designs by determining the value of each element or characteristics of

green spaces. Characteristics of urban green spaces are defined through factors such as facilities, accessibility, hygiene, attractiveness, perceived safety, and distance (Lee & Maheswaran, 2010; Yang, Li, Elder, & Wang, 2013). While characteristics differ for each urban green space, green spaces in general can help to show the psychological and social functionality of a space (Kaplan & Kaplan, 1989; Lee, Jordan, & Horsley, 2015; Wan & Shen, 2015). One specific factor that is associated with urban green space is the functionality and management of the upkeep (Wan & Shen, 2015). Previous studies suggest that the intention of use is highly influenced by accessibility and provided facilities. More positive attitudes and behavior can be a direct result of the perceived accessibility (Wan & Shen, 2015).

An important factor that communicates how people behave in natural settings is human preference. The elements of function and aesthetics can be generalized to all human preference (Kaplan & Kaplan, 1989). Function is the first factor that helps to determine human preferences by examining whether the space meets the needs of the user. Humans and even animals base the use of a natural setting through the functional use of the site (Kaplan & Kaplan, 1989). Kaplan and Kaplan (1989) found that visual and functional appeal differed according to individuals and these differences were defined further into the variances that appear through groups. The main factors that were found to cause variances in preferences were location, culture, and formal knowledge of the subject (Kaplan & Kaplan, 1989). These generalizations conclude that preferences can be difficult to predict as there are factors that can offset the usual pattern.

2.2 Green Space Benefits

Previous literature has found that there are social, physical, and economic benefits from the use of green spaces (Hartig & Evans, 1991; Kaplan, 1993; Kaplan & Kaplan, 1989; Lee, Jordan, & Horsely, 2015; Maas et al., 2006; Ulrich, 1979). Social benefits have been found to

affect environments such as the workplace, residential neighborhoods, and even city-wide communities (Kaplan, 1993; Kaplan, 1995; Kaplan & Kaplan, 1989; Lo & Jim, 2012; Lottrup, Grahn, & Stigsdotter, 2013; Stigsdotter, 2004; Taylor, Kuo, & Sullivan, 2002; Ulrich, 1979). Extensive research has supported and influenced greenways in public health on a national level. The National Park Service found that enhancing urban greenways could significantly reduce health care spending by creating more active spaces (National Park Service, 1995). As the importance of implementing urban green spaces became an essential issue, more studies had been conducted to analyze the relationship between humans and nature.

2.2.1 Health Benefits

Studies have found vegetation and natural features are factors that determine a positive relationship of health and urban green spaces (Chiesura, 2004; Lee & Maheswaran, 2010). Quality of life was shown to improve through the use of landscape features such as trees, water, and green belts (Chiesura, 2004). Results from previous studies have proven that the landscape encourages the use of outdoor spaces through social interaction (Kaplan & Kaplan, 1989; Taylor, Kuo, & Sullivan, 2002; Ward Thompson, 2002). The application of nature in a city environment has shown to provide not only relaxation but also air purification and sustainability (Chiesura, 2004). Development of sustainability is an important issue and only continues to become more imminent.

Urban green spaces have been found to provide not only social and environmental benefits but have also been found to positively affect physical health (Lee, Jordan, & Horsley, 2015). Evidence indicates the availability of green space provides significant opportunities of physical activities (Hannsman, Hug, & Seeland, 2007; Lee, Jordan, & Horsley, 2015; Maas et al., 2006). Regular physical activity, typically 30 minutes of exercise daily, has been shown to

improve health (Chiesura, 2004). Although evidence supports the health benefits of exercise, a lack of clean, safe, and open green spaces has created a decline in physical activity. The deficiency of policies and standards within cities only further limit the availability of green space (Lee & Maheswaran, 2010).

2.2.2 Mental Health Benefits

Green areas are often times used as therapeutic spaces for rehabilitation and healing (Ulrich, 1984; Ulrich et al., 1991). Contact with urban green space improves mental health by providing spaces for more social interaction (Lee, Jordan, & Horsley, 2015); specifically, participation in social events has been shown to improve mood. Opposite of using green spaces for social gatherings, people also use green areas for quiet restoration. Restorative environments are defined as a setting in which mental health is improved through factors of human preference and satisfactions (Kaplan & Kaplan, 1989). The key features of the restorative environment were identified through four aspects: experiencing escape from mental fatigue, sense of place through physical and mental properties, attention towards fascination, and the compatibility of the environment to the user are important in the restorative environment (Kaplan, 1995).

The four experiences that develop from the restorative environment reoccur in themes of the natural environment. The psychological effects of the four experiences supports a theoretical basis of natural settings. Being away, or escaping in psychological terms, means the experience of getting away from thoughts (Kaplan and Kaplan, 1989). Through the escape of mind, a restorative environment can create a sense of place in the experiences that result. For example, a park design can create an immediate sense of being in a different world. Elements of the experience of nature like clouds, textures, sunsets, and winds can attract one's attention (Kaplan and Kaplan, 1989). An individual may take the fascination and create a distraction or even take

pleasure through the reflection and engagement of the surroundings. One of the most important factors of the experience of nature is the compatibility of the environment to the individual. The use of natural settings takes less exertion compared to an urban environment. Natural settings are therefore more compatible towards different uses of the site. People perceive natural settings as fulfilling a wide arrange of needs through activities.

2.3 The Role of Green Space in Stress

Visits to green spaces have been found to provide a buffering effect on stressful life events (Van den Berg et al., 2010). Self rated mental health and stress is less pronounced than for physical health and general health indicators because self ratings for mental health are more strongly related to stressful life events. The availability, areas such as forests that are rich in vegetation, in one's living environment can provide opportunities for reflection and restoration on a deeper level (Grahn, & Stigsdotter, 2010; Van den Berg, et al., 2010). People can be affected by the amount of green space in their living environment depending on their personal needs and circumstances. This can be especially significant in high stress environments.

Major sources of stress can range from work, school, or even healthcare facilities (Hansmann, Hug, & Seeland, 2007; Lau & Yang, 2009; Lottrup, Grahn, Stigsdotter, 2013; Stigsdotter, 2004). As previous literature has stated, visiting green spaces can effectively reduce stress through activities such as walking, relaxing and observing (Hansmann, Hug, & Seeland, 2007). Furthermore, an increase in well-being was shown to be positively correlated with the duration of time spent in parks or forest settings (Rupprecht et al., 2015; Yang, Li, Elder, & Wang; 2013). Water has been found to have a particularly positive influence in well-being (Ulrich, 1984; Ulrich et al., 1991). People who report low levels of well-being before visiting the green space experienced large increases in personal wellbeing, especially in the presence of

water (Ulrich et al., 1991). There are many differences in the restorative effects experienced by people in different settings like forests and parks. These differences lead researchers to understand that green space settings have diverse roles in the development of restorative environments.

2.3.1 Green space in communities

The proximity of green spaces to neighborhoods and communities plays an important role for families with growing children. Studies have found mental health in children can improve through access to views of nature from their home. Researchers have found that when family homes are in close proximity to nature, it can lead to a more effective and self-disciplined lifestyle (Taylor, Kuo, & Sullivan, 2002). Green spaces can be used for physical activity or social gathering spaces which are associated with stress relieving factors. Social well-being has specifically been found to be a strong variable in relieving stress in communities. The accessibility of gardens can enhance people's sense of identity or belonging which in turn reduces the notion of social isolation (Ward Thompson et al., 2016).

Access to local green space can also decrease stress for communities (Taylor, Kuo, & Sullivan, 2002; Ward Thompson et al., 2016). The greater the accessibility to green spaces can have a significant impact in general health and perceived stress levels. This is due to the greater potential for personal or private use of green spaces in communities (Ward Thompson et al., 2016). While access is one factor that can effect the use of local green spaces, the quality of the green space is another important factor that determines the amount of use. For example, private gardens in neighborhoods are managed more efficiently leading to greater quality of that space (Ward Thompson et al., 2016). The difference in quality results in a stronger effect on the increase of perceived general health (Ward Thompson et al., 2016).

2.3.2 Green space in the work setting

The importance of greenery in the workplace environment has been studied to define the effects of varying amounts of access to green space between men and women (Lottrup, Grahn, Stigsdotter, 2013). According to the World Health Organization, work related stress is becoming a concerning topic among companies as it can have large psychological and economic effects (WHO, n.d.). Stress can have a significant effect on a worker's performance and may even lead to mental and physical health issues. By providing an area of vegetation that is accessible during the workday, positive work place attitudes can increase and the levels of stress can decrease (Kaplan, 1993; Lottrup et al., 2013).

Another factor that can impact employers in the work environments is the access to windows in the workplace. Windows are a source of light and sunshine and they also inform workers of the time, space, and weather of the environment outside (Kaplan, 1993; Stigsdotter, 2004). The features of the environment that are visible through windows can also have different effects on people. Built elements seen from windows will not provide any psychological benefits while views of natural elements such as the trees, landscape and vegetation can provide restorative qualities (Kaplan, 1993). Although, views of built elements such as buildings and parking lots can still be restorative as long as there are some views of natural elements. The natural elements provide rest from directed attention and therefore views of nature can be very beneficial (Kaplan, 1993). Visiting outdoor green space is also, if not more, restorative when features such as picnic benches and shady spots are accessible during lunch breaks (Kaplan, 1993). Studies have shown that nature that is accessible through walkways provide opportunities to observe wildlife for restorative benefits, stress management, and may even contribute to job

satisfaction and improved employee outlook (Kaplan, 1993; Lottrup et al., 2013; Stigsdotter, 2004).

2.3.3 Green space in the healthcare setting

Nature has first been used for healing about 3,000 years ago (Spriggs, Kaufman, & Warner, 1998) and many recent studies support the many benefits from human contact with nature (Kaplan & Kaplan, 1989; Whitehouse et al., 2001) Healthcare facilities are an especially stressful environment due to their unfamiliarity, negatively portrayed image, and connection to events that cause exhaustion (Kaplan, 1993). Therefore, it is important for landscape architects to understand how to more efficiently design healthcare environments to focus on comfort and familiarity. Previous studies have found benefits from direct contact or views of nature; Ulrich (1984) found reductions in stress levels and health-related complaints, Kaplan (1993).

Gardens in the hospital settings must provide restorative elements in order for patients and families to benefit from the healing effects of green spaces. Specific elements that have known to bring healing include: sunlight, location, views, access, safety, wayfinding, planting design, and maintenance (Davis, 2011). However, each hospital space must be diverse in order to provide for each targeted population. For example, children's hospitals should be designed with many colors and safe places for children to explore while elderly populations with Alzheimer's must have specific measures of safety precautions for every detail of design.

A large percentage of users of green spaces in hospital settings are staff and adult family members with hospitalized children (Whitehouse et al., 2001). A recent study by Whitehouse et al. (2001) found that adult family members and staff used green space to relax and talk with children in the garden. The sounds of water and colors of plants provide an escape from stress and designated areas provide an environment away from the hospital for socializing. Results

from the study found a 90 percent positive change in mood after visiting garden spaces. While adults use the gardens as a place to relax, children are often found to use garden spaces to explore and play.

2.3.4 Green space in a campus setting

Universities can be one of the most highly sensitive environments due to their stressful nature (Felsten, 2009; Hipp et al., 2016; Speake, Edmondson, & Nawaz, 2013). This results in immense pressure on the mind and body and planners and landscape architects strive to design green spaces that offer healing through campus design (Felsten, 2009). Students and university staff are often fatigued from academics and there are numerous opportunities that are not maximized to connect the indoor and outdoor campus settings.

Research has found that students who viewed real or simulated nature had the most potential to receive restorative effects (Felsten, 2009; Hipp et al., 2016). A previous study (Felsten, 2009) evaluated the perceived restorative potential of campus settings through measuring the restorativeness of nature murals on college students. The study found settings of nature with water had the highest restorative potential and identified other influences on the perception of restorativeness of campus settings. Researchers concluded that window views of nature should be provided whenever the opportunity arises (Felsten, 2009).

Spaces such as healing gardens or natural forest areas have been shown to provide healthy environments that promote outdoor study areas and recreational activity space (Van den Berg, Koole, & Wulp, 2003). By providing green spaces close to campus residences, nature is able to provide psychological benefits such as stress attenuation and attention restoration (Grahn & Stigsdotter, 2010). Healing gardens in particular are able to provide and enhance healing through the surroundings (Ulrich, 1984; Lau & Yang, 2009).

The importance of campus green space shows that campuses need to supply multiple forms in order to satisfy the requirements of diverse student users (Speake, Edmondson, & Nawaz, 2013). The perception of greenness can impact the opportunities for restoration and thus the university campus environment has greater potential using green space as a health resource for students when the perception and knowledge of green space is greater (Speake, Edmondson, & Nawaz, 2013). As stated earlier, green environments signal opportunities for leisurely activities and social contact which are associated with positive social participation, important experiences for college students. Familiarity plays an important role in influencing the perception of green space and therefore as awareness increases, the use of green space increases (Speake, Edmondson, & Nawaz, 2013). Green spaces have the potential to serve as a strong symbol for universities and positively contributes to student life experiences on campuses leading to greater sense of identity (Speake, Edmondson, & Nawaz, 2013).

2.3.5 Campus Planning

An important part of the history of how today's university campuses are designed is the study of campus planning. Campuses are carefully designed and maintained by campus planners and can include several disciplines such as architecture, planning, engineering, landscape architecture, urban design, and environmental practices (Smithgroup JJR, n.d.). The design of master plans for universities goes through a thorough process of planning and guidelines that include factors such as cost, performance, maintenance, construction, creativity, as well as considering the public health (Smithgroup JJR, n.d.). Campus planning plays a critical role in promoting the health, safety, and welfare of students and many times designers also must find solutions to existing problems within the site (DeClercq, 2016). These solutions include creating a bridge between students and the campus environment. Emphasis should be placed on campus

planning due to the social, physical, and metal benefit these environments can provide (DeClercq, 2016).

2.4 Study Intent

This study tests to see whether students prefer using a space with more green elements in relieving stress over a space with less green elements. The hypothesis is that the spaces with more greenness are perceived as providing more stress relieving effects to most students. In the present study, data was collected from a diverse sample of Michigan State University students to investigate the existing and potential possibility of campus green space in reducing stress. In contrast to the previous studies, perceived stress of students was measured on two varying degrees of greenness of ten different places on campus. Five highly used green spaces on campus and five highly visited built environments of campus to gain more insight on the impacts of urban development versus natural landscapes on reducing stress. Since Michigan State University enrolls both students from all around the nation and international students, the data can show the results of a diverse population. In 2016, 71% of students at Michigan State reported that they had experienced stress, which could lead to a decrease in academic performance, sleeping patterns, anxiety, and a weakened immune system (Michigan State University, 2017). Because students have high concentrations of stress, the university has many programs to support student health and the data from this study may help to address these problems.

Chapter 3. Methodology

3.1 Location

The present study is located at Michigan State University in East Lansing, Michigan. The institution was established in 1855 and is one of the nation's first land-grant universities. Land grant universities are institutions that the Federal Government has designated to receive benefits from the Morrill Act of 1862, 1890, 1994 (Miller, 2016). The goal of the Morrill Acts was to provide working class citizens the opportunity to gain practical education through grants designated to the fields of agriculture, military, and mechanic arts (Miller 2016). Michigan State University is a nationally ranked research university with a diverse community of students from all over the world. The campus is comprised of a total of 5,200 acres with 2,100 acres of existing or planned development. There are approximately 50,000 students enrolled with about 39,000 undergraduate students and over 11,000 graduate and professional students (Michigan State University, n.d.).

3.2 Procedure

A sample of both undergraduate and graduate students at Michigan State University were asked to participate in a survey. Before conducting the survey, the researchers submitted the survey to the Michigan State University institutional review board (IRB) and was granted approval [x17-134e]. The survey was conducted in three locations on campus: Owen Hall, the Human Ecology Building, and the MSU Union. The locations were chosen to ensure diversity and generalizability of the study. The sample was a convenience sampling (Nejati, Rodiek, Shepley, 2016) and students were asked to participate in the survey at the three locations during the spring semester of 2017. The survey consisted of two parts: (1) demographics and open ended questions and (2) a visual quality assessment. In order to understand respondent

perceptions, the demographics asked for four variables on the background of student's gender, residence (on or off campus), the approximate amount of time the respondent visits a green space, and reasons why one would use a campus green space. The questions were then followed by a visual quality assessment ranking for images of campus.

3.2.1 Selection of Images and Image Editing

During the visual quality assessment, respondents were shown five sets of four photos, for a total of 20 images, and were asked to rank each set from 1- 4, where 1 signifies the least stressful image to 4 signifies the most stressful image. To generate the overall 20 images, ten sites were selected by finding frequently visited and centrally located places on Michigan State University's campus, shown in Figure 1. Each of these existing ten site images were modified through photo editing software (Photoshop CS6 Software) to produce another ten images, shown in Figure 2. For five of the existing sites, the photos were altered by adding additional green features, while the remaining five existing sites were altered by adding more hardscape (Table 1).

Figure 1.

The ten sites chosen for the visual quality assessment photo ranking analysis.



Figure 2. Image b (left) and image p (right).



Table 1.

Organization of original and photo edited images.



Table 1. (cont'd)



3.2.2 Data analysis

The data from the visual assessment were analyzed using the Friedman two-way analysis of variance by ranks, which is a non-parametric statistical test using ranks to measure the distribution between three or more related samples (Daniel, 1978). In Freidman's two-way analysis of variance by ranks, there is no minimum number of blocks (other than 2), and the power of the test is best at five or six blocks. Each respondents' perception on effects of the 20 images in reducing stress was ranked from 1-20 and added into a table where the respondents were divided in to groups. In order to find whether the data provides sufficient evidence indicating the green value in reducing stress, the computational formula was used to test for the differences in the rank sums by:

$$x_r^2 = \frac{12}{bk(k+1)} \sum_{j=1}^k R_j^2 - 3b(k+1)$$

The formula is explained through the following (Daniel, 1978):

- b represents the number of blocks;
- k represents the number of treatments;
- R_j^2 represents the sum of the ranks for each treatment;
 - In the case of rank ties, we adjust to take the ties into account using the formula:

$$C = 1 - \frac{\sum_{i=1}^{b} (t_i^3 - t_i)}{bk(k^2 - 1)} \quad \text{followed by } x_r^2 / C$$

- C is the tie correction factor
- Where T is the total number of tie series and t_i is the number of tied scores.

The data was tested for two hypotheses as follows:

- The null hypothesis of H₀: the treatments yield identical results.
- The alternate hypothesis of H₁: at least one treatment tends to yield larger values than at least one other treatment.

In the case that the null hypothesis is rejected and the alternate hypothesis is accepted, the following formula will be used to find the significant differences between the treatments (Daniel, 1978):

$$\left|R_{j}-R_{j'}\right| \geq z_{\sqrt{\frac{bk(k+1)}{6}}}$$

Chapter 4. Results

There were 72 respondents grouped into 6 groups of 12 respondents. Table 2 shows the results of the sum of ranks for each image for each block. Using the computational formula, the ranking of each image was calculated and used to find the significance between the 20 images. The sum of ranks for the each of the 20 images and were divided in to 12 groups which can be seen in Table 2. Using the Friedman two-way analysis of variance formula above, the variables from Table 2 were used to find the computational chi-square:

$$x_r^2 = \frac{12}{6 * 20(20+1)} (92.5^2 + 89^2 + 113^2 + 115.5^2 + 46.5^2 + 22.5^2 + 66.5^2 + 9^2 + 52^2 + 110.5^2) - 3 * 12(20+1) = 127.6011905$$

The computational chi-square was then computed for the adjustment of ties:

$$C = 1 - \frac{26(2^3 - 2) + 2(3^3 - 3)}{6 * 20(20^2 - 1)} = 128.066$$

Table 2.Sum of ranks for each image in each block.

									Trea	ments										
Blocks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Group 1	13	15.5	19	20	6	2	12	1	7.5	18	10	10	11	17	3	5	7.5	5.5	10	15.5
Group 2	15	17	18	19	12	3.5	14	1	9.5	20	5.5	11	6	16	3.5	8	7	2	9.5	13
Group 3	18.5	16	18.5	20	11	1	13	2.5	8.5	17	2.5	8.5	6.5	11	4	14.5	5	6.5	11	14.5
Group 4	17	13.5	18.5	18.5	9	6.5	4.5	2	10.5	20	15	8	13.5	12	1	10.5	6.5	3	4.5	16
Group 5	12	11	19	20	3.5	6	9.5	1	8	16.5	13.5	15	18	16.5	2	9.5	5	3.5	7	13.5
Group 6	17	16	20	18	5	3.5	13.5	1.5	8	19	10	7	13.5	15	3.5	11.5	1.5	1.5	6	9
R (sum)	92.5	89	113	115.5	46.5	22.5	66.5		9 5	2 110.5	56.5	59.5	68.5	87.5	17	59	32.5	22	2 4	8 81.5

In order to accept or reject the null hypothesis, the computational chi-square must be greater than or equal to the tabulated chi-square. According to the table found in *Applied nonparametric* statistics, by Daniel (1978), the tabulated chi-square is found through the degrees of freedom. The degrees of freedom is calculated by the formula k-1, which in this case was 19; therefore, the tabulated chi-square is 38.582. Because the computed chi-square was found to be

larger than the tabulated chi-square, the resulting data was found to reject the null hypothesis and the alternate hypothesis was accepted.

Given the alternate hypothesis was accepted, the data was further analyzed to find the image comparisons with an alpha level of significance. The formula by Daniel (1978) was used to compare the multiple treatments with an alpha (α) of 0.005, which means the there is a 0.5 percent chance of making an error of rejecting a null hypothesis that is true. Using the multiple comparison formula, it was found that if the difference in the sum of ranks was larger than 74.8 the images are considered significantly different for an alpha of 0.005. The images comparisons with significant differences were recorded in Table 3. This table shows that respondents repeatedly preferred the same five images over other images. From the table, it shows that the images perceived as least stressful were images d, a, l, r, and t. The images are described as follows: image d is of a garden plaza space behind the chemistry building on campus (see figure 3), image a is the Red Cedar River behind the Hannah Administration building (see figure 4), image l is the altered photo of the plaza in front of the main library (see figure 5), image r is the photo altered image of the Red Cedar River (see figure 7).

Table 3.

Pairwise comparisons of images with significant differences. Calculations based on the non-parametric statistics (Daniel, 1978) using an alpha level of 0.005.

Pairwise Comparison Scores								
_								
Images	value l	value 2	difference					
d & i	22.5	113	90.5					
d & f	22.5	115.5	93					
d & g	22.5	110.5	88					
a & s	9	92.5	83.5					
a & j	9	89	80					

Table 3. (cont'd)

a & i	9	113	104
a & f	9	115.5	107
a & g	9	110.5	102
a & m	9	87.5	78.5
1 & s	17	92.5	75.5
1 & i	17	113	96
1 & f	17	115.5	98.5
l & g	17	110.5	93.5
r & f	32.5	115.5	83
r & g	32.5	110.5	78
t & i	22	113	91
t & f	22	115.5	93.5
t & g	22	110.5	88.5

Figure 3. Image d: Formal garden space on campus.



Figure 4. Image a: Red Cedar River.



Figure 5. Image l: photo altered main library.



Figure 6.

Image r: photo altered open green space next to the biomedical and physical sciences building.



Figure 7. Image t: photo altered Red Cedar River.



Regarding the demographic questions in the survey, out of the 72 respondents 33 were male (46%) and 39 were female (54%) (see table 4). The data included the number of respondents who live on campus, 53%, and the number of respondents who live off campus, 47%. During the open-ended questions in the survey, respondents were asked to provide a reason or activity they would use a campus green space for and table 3 below shows the results categorized into six themes. The themes include: sports, relaxing, exercise, studying, socializing, and other recreation for activities that could not be put in to one of the other five categories. Sports and relaxing were the top two reasons for males (61%) on the use of green space followed by studying (33%), other recreation (33%), exercise (27%), and socializing (21%). Studying (56%) and other recreation (49%), such as reading, were the top two reasons for females followed by socializing (41%), sports (36%), relaxing (36%), and exercise (33%).

Table 4.

G			
Green space use	Male (n=33)	Female (n=39)	Total (n=72)
Sports	61% (n=20)	36% (n=14)	47% (n=34)
Relaxing	61% (n=20)	36% (n=14)	47% (n=34)
Exercise	27% (n=9)	33% (n=13)	31% (n=22)
Studying	33% (n=11)	56% (n=22)	46% (n=33)
Socializing	21% (n=7)	41% (n=16)	32% (n=23)
Other Recreation	33% (n=11)	49% (n=19)	42% (n=30)
Residence			
On Campus	52% (n=17)	54% (n=21)	53% (n=38)
Off Campus	48% (n=16)	46% (n=18)	47% (n=34)
Time spent in green space (per			
week)			
1-3	27% (n=9)	41% (n=16)	35% (n=25)
3 or more	61% (n=20)	51% (n=20)	56% (n=40)
0 or rarely	12% (n=4)	8% (n=3)	10% (n=7)

Demographic data showing uses of green space.

Chapter 5. Discussion

5.1 Evaluations

This study compared the potential of ten campus spaces with varying degrees of green features in reducing stress. An important element of the study was being able to show the potential of campus spaces through the photo alteration technique using the Photoshop CS6 software. This factor allows the researchers to take a space and directly compare the results of the possibility of the same space to have different design. The analysis shows an overall perception of naturalistic campus settings preferred as a less stressful setting when compared to settings with minimal green. Within the photo categories, the results reveal that the original photos with maximum green spaces were perceived as more stress reliving, especially natural settings with a water feature. The data supports this theory because the only pair of original and photo altered images that ranked significantly less stressful than other images were images a and t, which viewed the Red Cedar River (See Figure 4 and Figure 7). This was an expected outcome as previous literature had found that people prefer environments that utilize water features (Ulrich, 1984; Ulrich et al, 1991).

People may prefer spaces that include a water feature due to many reasons. One reason could be that people associate water with different outdoor activities, such as canoeing or kayaking. Another reason may be that the water features give people something to easily get their mind off of stressful thoughts, which previous research shows is one psychological benefits from viewing nature (Kaplan & Kaplan, 1989; Ulrich, 1984). Although images with water features were the preferred setting, the images with the river was favored over the image with the fountains. This can be explained due to the difference between visual access and physical access of rivers and fountains. While the physical access in terms of touching water is equal in both the

case of a river and water fountain, people are able to immerse themselves in rivers in turn creating more activities and social interactions. In addition to the preferences for the images of natural settings, there were multiple photo altered images with added built elements that were still preferred over the photos of natural settings. These statistics may conclude that there are certain hardscape elements that people desire in a natural environment.

Photo altered images that were preferred stress relieving settings included images l, r, and t (see figures 5, 6, and 7). Images r and t were photo altered images that added built elements such as concrete plaza space and pathways (see figures 6 and 7). The factor these two images have in common is water features. Although the water feature in image t is the existing Red Cedar River, image r was photo altered to include a fountain. Students may prefer these images due to the quiet restoration or natural water sounds. This may infer that noise may be a large factor in producing a more restorative setting for relaxing and studying. The factor of what triggers relaxation could be further explored in another study where people could be asked what features of the photo could make them feel less stressed. Another unexpected outcome that may explain the importance of accessibility and aesthetics was the outcome of image d, which ranked the second most least stressful. This area of green space can be considered a formal garden space due to the existing concrete and brick paths and sitting areas that are designed with a symmetrical purpose. According to previous research, accessibility is a large factor that controls whether a person would use a space (Lee & Maheswaran, 2010; Wan & Shen, 2015; Ward Thompson et al., 2016). The pathways and benches are inviting features and encourage people to stay within the space. For this reason, more students may have chosen the formal garden space as a stress relieving environment.

The survey's open ended questions of the survey aimed to gather information on how the campus student population uses campus green spaces. The results showed the majority of males and females used green spaces for different uses. These results were also parallel to another study that found differences between men and women (Lottrup, Grahn, Stigsdotter, 2013). While a high percentage of males (61%) indicated they used green spaces for physical activities like sports or for relaxing, most of the female respondents (56%) indicated they used green space for studying. A further study could test for this factor by observing people using green spaces and recording the different activities students participate in green spaces. This difference in uses may dictate the type of built elements that should be implemented into green spaces. For example, if more benches are designed into green spaces it may provide more opportunities for students to relax and study. To also accommodate uses for males, there should be ample open space for activities such as football or soccer.

Through the qualitative survey questions, it was often found that students had little awareness of what constituted a campus green space was. In addition, Table 4 shows ten percent of students rarely used green spaces. It could be inferred that students the use of green space was limited by lack of knowledge on the existence and location of available green space. One main reason students may not have known about the existence of campus green spaces could be the lack of wayfinding and signage. For many students, college is often the first experience without family and students must acclimate to a new surrounding. Many students rely on signage to find areas on campus and so without signs or maps pointing out areas of interest, students are often unaware of the services provided on campus. In future studies, a method to find the issues of knowledge of green space may be to have a question asking if respondents know what a green space is and where they may be located on campus. Implementing more green spaces and

wayfinding may help to educate students on the knowledge and awareness of campus green spaces.

University campuses are spaces that harbor stress and mental fatigue, yet they hold abundant opportunities to repurpose spaces to reduce stress. The findings from this study supports previous literature that has found green spaces to be more stress relieving compared to built environments. Campus planners and designers can use the data to find which built spaces can be reimagined with green elements in order to serve multiple purposes for diverse student populations. Given that natural green spaces with water were preferred, design guidelines could be recommended for the future of Michigan State University's campus. Planners could focus on three main elements found through this study: visual accessibility, physical accessibility, and the utilization of water features.

5.2 Limitations

This study has many limitations that should be addressed for the needs of further research. A large limitation factor that could have restricted the rankings of the images is the methodology. The methodology of the present study combined methods from many different studies (Burley, 1996; Burley, DeYoung, Partin, & Rokos, 2011; Nejati, Rodiek, Shepley, 2016). One limitation of the data collected is that the study was determining rankings based upon perceived, rather than actual, stress levels. Therefore, all resulting data was based upon the correlation of perceived stress versus measured stress levels whereas previous studies have analyzed stress levels through evidence based measures, such as heart rate, blood pressure, attention tests, brain activity, and behavior observation (Taylor et al., 2002; Ulrich et al., 1991; Ulrich, 1984; Van den Berg et al., 2003).

Although many previous studies included self-perceived health levels (Kaplan, 1993; Maas et al., 2006; Ulrich, 1979), the present study had analyzed the perception of stress from viewing landscape images. While direct contact with nature could affect the results, it is not possible to determine if there would be a large difference in the perceived stress levels. Researchers that have conducted landscape visual quality assessments had randomized the order and groupings of the landscape images; however, the present study did not fully randomize the groupings of photos. Since the photos were altered through the use of editing software, the images were slightly seeded so that in each set there were 2 photo edited images and 2 non photo edited images of each type of greenness level. The seeding of the images could have caused a difference in the rankings. A similar study that might have been useful in finding the effects of nature is through recording students stress levels after physically experiencing a space. Due to time and weather constraints, the visual assessment through photos was the preferred method.

Another limitation may be the sampling technique and sample size. The sample size is small compared to the number of students that attend Michigan State University and the results could have differed with a larger sample size. The data was collected from only three different buildings on campus: Michigan State University Union, Owen Hall dormitory, and Human Ecology building. Students were asked inside of these buildings during the afternoon during the middle of spring semester. This could have potentially influenced the results due to the different student population located in each area. The Owen Hall dormitory is a graduate and undergraduate hall with a high population of international students which gave the range of sample populations a wide range of backgrounds while the Human Ecology building is generally occupied with students in the School of Planning, Construction. The school includes landscape architecture, urban planning, and construction management students who have a background

knowledge and are educated on the benefits of nature. Therefore, respondents from the Human Ecology building may have chosen image settings that were more likely to be chosen for people who prefer outdoor settings.

5.3 Conclusion

This study aimed to find stress relieving variables in the design of university campus green spaces. The findings of this study supported the idea that students can benefit more from a naturalistic green space, however factors such as site amenities, water features, and accessibility are factors that may determine the amount of use of a specific green space. Spaces with natural and man made water features were found to be the most stress relieving space, suggesting more utilization of existing water features and opportunities for built water features. The parks must also have a balance of activities in order to allow the potential for a space to accommodate diverse student populations.

The results of this study will aid future landscape architects and planners in providing recommendations for urban and open green space to incorporate the needs and wants of student population to decrease stress levels. By educating and providing green spaces on campus, it may encourage students to use green spaces to relax and encounter nature. The benefits are especially important in areas of high stress environments and thus a recommendation of amount of green features should be developed to design the most efficient spaces. However, there is still further research that could be done to understand the psychological benefits of urban green space.

APPENDIX

You are being asked to take part in a study to assess perceptions on your levels of stress on campus and how this correlates with open and green spaces on campus. You will be given a scenario and asked to respond what your perceived level of stress would be at three different spaces on campus.

Your participation in this survey is voluntary and you have the right to withdraw at any time. Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact the lead investigator Dr. Trish Machemer at machemer@msu.edu.

If you agree to take part in this research, please confirm below and continue on to the questionnaire. Thank you for considering to participate in this research project.

Would you be willing to participate in this survey?

- □ Yes, I would like to participate in this survey.
- □ No, I would not like to participate in this survey.

To help assess the needs of Michigan State University's student community, we need to first understand who you are as a person. Please take the time to answer every question on the survey. Your responses will stay anonymous as required by the Institution Review Board (IRB).

- Gender:
 Female
 Male
- 2. Residence:On CampusOff Campus

You will be shown four sets of images with four images in each set. Please view each set and rate from 1 to 4 on what you perceive is the least stressful environment (1) to the most stressful environment (4).

Set 1:

- 1. Least stressful image #:
- 2. Image #:
- 3. Image #:
- 4. Most stressful image #:

Set 2:

- 1. Least stressful image #:
- 2. Image #:
- 3. Image #:
- 4. Most stressful image #:

Set 3:

- 1. Least stressful image #:
- 2. Image #:
- 3. Image #:
- 4. Most stressful image #:

Set 4:

- 1. Least stressful image #:
- 2. Image #:
- 3. Image #:
- 4. Most stressful image #:

Set 5:

- 1. Least stressful image #:
- 2. Image #:
- 3. Image #:
- 4. Most stressful image #:

Please read and answer the following questions about Michigan State University's green space.

- 3. How often do you spend outdoors on campus:
 - \Box 3 or more times per week
 - \Box 1-3 times per week
 - \Box 0 or rarely
- 4. What are some reasons/activities you would use campus green spaces for:

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