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*Corresponding author: Verna DeLauer Franklin Pierce University, United States
E-mail: delauerv@franklinpiercedu

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Additional information is available at the end of the article

GEOGRAPHY | RESEARCH ARTICLE

The impact of natural environments and biophilic design as supportive and nurturing spaces on a residential college campus

Verna DeLauer^{1*}, Andrea McGill-O'Rourke², Tyler Hayes², Ashley Haluch², Carissa Gordon², Julia Crane², Dena Kossakowski², Carina Dillon², Nicole Thibeault² and Daniya Schofield²

Abstract: With so many college students experiencing disengagement, the physical design of a college and the connection to its natural surroundings has the potential for profound change. Natural environments, even viewing pictures of them, have the potential to positively impact parasympathetic nervous systems, increase cognitive functioning, and improve attention. This study investigated college student perceptions of their personal well-being with attention to coping, self-esteem, and physical health in a residential academic setting in the northeastern United States. Female students reported less resiliency, lower self-esteem, and a decreased ability to choose positive health behaviors than male students. Findings point to the potential for the built environment on a college campus to be designed with biophilic elements to support and nurture students all year long.

Subjects: Environmental Studies; Environment & Gender; Environment & Health

Keywords: Stress; nature; restorative; university; college; biophilic design; health geography

ABOUT THE AUTHOR

Dr. Verna DeLauer is an environmental studies professor at Franklin Pierce University in New Hampshire. Dr. Andrea McGill O'Rourke is a health administration professor at Husson University in Maine. Together, they oversaw several years of a National Institutes of Health funded research lab. Our research lab is interested in how place and space contribute to the well-being of young adults in college. We have explored the mix of independence and interdependence young adults use when making mental and physical health decisions and the extent to which students of different genders or ages exercise agency. We have also explored how the natural and built environments of college campuses influence all of the above. Our work is relevant to college administrators hoping to increase student retention by providing more nurturing features that result in a stronger attachment to place.

PUBLIC INTEREST STATEMENT

College students are experiencing increasingly, higher levels of mental illness and stress. This impacts their capacity for succeeding in school. Spending time outdoors and/or bringing natural elements indoors has been shown to improve mental health and attention-span. This study investigated college student perceptions of their personal well-being with attention to mental and physical health in a residential academic setting in the northeastern United States. Female students reported lower self-esteem and a decreased ability to choose positive health behaviors than male students. Younger students reported less resiliency. Findings point to the potential for the built environment on a college campus to be designed nature-in-mind to support and nurture students all year long.

1. Introduction

Today, college students are experiencing unprecedented rates of mental illness (Hubbard et al., 2018) and stress (Kumaraswamy, 2013). The transition to college may create a situation where regular contact with traditional supports, e.g., friends from high school and family, is reduced. The ability of such social supports to mediate the effect of exposure to stress has been documented (Thoits, 1995). College also marks a period where new systems of social support are being created.

1.1. *Stress in the college-aged student*

In the college-aged population (on average 18–22 year old) research has consistently linked stress with a variety of negative behaviors (e.g., substance misuse, violence, suicide ideation, etc.) and stress-related symptoms (e.g., depression, anxiety) (Dyson & Renk, 2006; Largo-Wight et al., 2005; Lee & Goldstein, 2016; Regehr et al., 2013; Yusufov et al., 2019). College students reported more than average or tremendous stress (67%); feeling overwhelming anxiety (61%); hopelessness (51%); and 13.2% had been diagnosed or treated for depression or anxiety (Britz et al., 2017). The causes of these emotional distresses are numerous, including competition for grades, technologically-prompted isolation, rejection, dissolutions of relationships, depression, and feelings of low self-esteem and severe financial pressures. Anxiety, stress, and depression can impact cognitive and attentional capacities. Students who had high levels of stress, or difficulties handling stress, reported physical health issues affecting their diet and sleep (Britz & Pappas, 2010; Hudd et al., 2000; Richards & Specker, 2021).

1.2. *The impact of natural environments as stress-reducers*

One self-reported benefit of exposure to both nature-rich urban places and wilderness areas, is stress mitigation (Kaplan, 1995; Martin et al., 2020; Ulrich et al., 1991). Stress is a natural physiological phenomena that protects humans from danger. When stress occurs, the human body prepares for immediate action by releasing hormones that increase alertness and focus. However, if the source of stress does not disappear, stress hormones can persist in the body (Sharma et al., 2018). Research into the benefits of natural environments to ameliorate the negative side effects of stress takes on heightened importance because stress and for some demographics, chronic stress, is a pervasive public health issue that can exacerbate physical health (Ohly et al., 2016; Tyrväinen et al., 2014).

Further, being immersed in a natural environment has been shown to have positive benefits to one's mental and physical health. Exercising in nature, relaxing in nature, and socializing in nature have all been connected to individual well-being. These aspects even have the potential to impact one's physiology (Ryan et al., 2014).

People may experience feelings of peace and tranquility when in a natural environment or even when viewing pictures of nature (Vining et al., 2008). Within the past 30 years, there is increasing evidence that spending time in natural areas has both real and perceived physiological and psychological benefits (M. C. Kondo et al., 2018; Hartig et al., 2014; James et al., 2015; Shanahan et al., 2016; White et al., 2017).

The psycho-evolutionary theory (PET) posits that natural environments are effective in reducing stress levels because they offer specific attributes that our species views as having survival qualities, such as water and spatial openness (Ulrich et al., 1991). Kaplan and Kaplan (1995) developed the Attention Restoration Theory (ART) which posits that natural settings possess a particular set of properties that promote restoration from attention fatigue. Hartig (2008), combined PET and ART demonstrating that exposure to the natural environment can either be mediated through psychological restoration or in increased physical activity. These findings are consistent with other studies that have found that anything from a grassland to a waterfall can provide the restorative mental health benefits of nature (Antonelli et al., 2019).

Table 1. Grade Level ANOVA and Browns-Forsythe Results

Question	ANOVA (p-value)	Browns-Forsythe Significance*
Employment	.000001	.000041
Q1	.056	.052
Q2	.569	.601
Q3	.616	.552
Q4	.603	.590
Q5	.000041	.000070
Q6	.102	.099
Q7	.956	.948
Q8	.060	.098
Q9	.063	.056
Q10	.340	.405
Q11	.380	.358
Q12	.314	.346
Q13	.013	.009
Q14	.227	.254
Q15	.001	.001
Q16	.844	.788
Q17	.112	.119
Q18	.044	.031
Q19	.060	*N/A
Q20	.394	.356
Q21	.173	.113
Q22	.233	.205

*Browns-Forsythe test failed because at least one group had 0 variance

Table 2. Grade Level Post-Hoc Analyses Results

Question	Post-hoc Qualitative Description	P-value
Employment	More seniors are employed than freshmen	.000002
	More juniors are employed than freshmen	.002
Q5	Seniors work more hours per week than freshmen	.006
	Juniors work more hours per week than freshmen	.000084
Q13	Seniors are more confident than juniors	.045
Q15	Freshmen get more sleep than juniors	.003
	Sophomores get more sleep than juniors	.003
	Seniors get more sleep than juniors	.013

(Continued)

Table 2. (Continued)

Question	Post-hoc Qualitative Description	P-value
Q18	No significant differences found between any groups. Though the null hypothesis is still rejected due to the significant ANOVA test	N/A

Table 3. Gender. Significance values for t-test and Levene's test and a description of the significant differences found

Question	P-value	Levene's Test
Employment	.878	.762
Q1	.700	.336
Q2	.169	.361
Q3	.359	.333
Q4	.010	.995
Q5	.455	.800
Q6	.833	.305
Q7	.062	.003
Q8	.008	.601
Q9	.000019	.000284
Q10	.024	.115
Q11	.270	.041
Q12	.012	.000250
Q13	.000136	.013
Q14	.000037	.080
Q15	.004	.045
Q16	.264	.014
Q17	.445	.294
Q18	.101	.076
Q19	.071	.658
Q20	.007	.148
Q21	.000008	.007
Q22	.143	.562

Natural outdoor environments, especially green spaces, have been associated with better objective and subjective physical health including: self-perceived health (De Vries, 2013, p. 2003; Pasanen et al., 2014; Passmore & Howell, 2014), well-being (White et al., 2013), longevity (Mitchell, 2013), cardiovascular diseases (Pereira, 2013; Tamosiunas et al., 2014), recovery from illness (Ulrich, 1984), symptoms experienced (De Vries et al., 2013), among others.

Natural outdoor environments have also been associated with better mental health including: general mental health (Korpela et al., 2014; Lee et al., 2014; Mitchell, 2013; De Vries, 2013), perceived mental health (White et al., 2013; Richardson et al., 2013), anxiety (Martyn & Brymer, 2016), stress, depression, and/or anxiety symptoms (Pearson & Craig, 2014; Tamosiunas et al., 2014), anxiety or mood disorder treatment (Nutsford et al., 2013), mood enhancement (Brooks et al., 2017), cognitive and attention capacity, and cognitive capacity and stress-related illnesses (Grahn & Stigsdotter, 2003).

Restoring or improving human-nature relationships will likely depend on promoting opportunities for more frequent experiences in nature. Since January, 2020, COVID-19 has challenged individuals, communities, and society as a whole to rethink basic assumptions and best practices. Most research indicates that the coronavirus is more easily transmitted indoors than outdoors (Samuel, 2020). Being outside is suddenly not just “nice,” it is potentially life-saving. A survey by Civic Science found that 43% of Americans aged 13 and over said they engaged in more outdoor activities due to COVID-19 social distancing protocols. Of those activities, hiking, visiting local parks, and boating/fishing were the most likely to see a boost (Brode, 2020).

1.3. Biophilic design and restorative landscapes

There are contested definitions of what is natural and the extent to which humans are a part of or separate from nature (Laland et al., 2018). In Hinchliffe’s *Geographies of Nature* (2007), nature is conceptualized in three overarching ways: 1. Nature as independent from society thus taken as object that can be ignored or be seen as in need of protecting. 2. Nature as dependent on society conceptualized solely through human imagination. 3. Nature as co-produced existing both independently and dependently, simultaneously. The setting of our case study is a rural college campus with 1200 acres and diverse forest and wetland ecosystems. The students often refer to the campus as “the country club.” Some of the land is wild and some is managed. Using Hinchliff’s theory of the ways in which nature exists, we see all three of these geographies at play. The campus “country club” is space that students use to meet their goals but generally ignore natural areas (Carty, 2020 Personal Communication). Conceptually, nature is perceived uniquely by individual students. Physically the natural areas on campus, for some students, do become meaningful places that impact their sense of themselves as a community member.

Here we are interested in the qualities of natural environments that feel nurturing to students and to what extent those same qualities can be reproduced within the built environment of campus. We draw from the concept of biophilia (literally “love of life”) or the human inclination to connect with nature (Kellert & Calabrese, 2015; Wilson, 2002). This human inclination can be met in a variety of ways and does not require regular access to a wilderness area, for example. Biophilic design within the built environment has been found to promote a sense of place; yet studies are lacking in how nature-based design is conducted on college campuses (Peters & D’Penna, 2020). A biophilic design may include a visual (view of trees) or non-visual connection (sound of wind) to nature while indoors, fresh air or natural lighting within a classroom building, material connection through the use of wood construction, and feelings of prospect, refuge, and mystery within four walls.

Studies have shown that there are physiological and psychological health benefits to environments that incorporate biophilic design attributes such as higher than required levels of daylight, carefully placed windows to frame views outside, appropriate variety in lighting levels, using natural materials, bringing nature indoors by incorporating plants, utilizing green roofs, and maximizing green spaces around buildings (Browning et al., 2014). University environments that incorporate these biophilic design elements could maximize the restorative qualities of the environment [Kaplan, 1995; Berman et al., 2012], helping students feel less stress, and be able

to focus on their learning. However, there is a lack of research on the benefits of biophilic design in university settings. The transition from a secondary to post-secondary learning environment is important for students and is linked to increased independence and maturity. Studies also show it is a time of uncertainty that affects mental health and academic productivity in a way that is unique to this demographic group (Mannerström et al., 2019; Wu et al., 2020).

As a way to improve the overall well-being of students and reduce stress, colleges and universities who do not have access to a lot of green space can create natural settings indoors. Nature can be brought inside in a variety of different ways, such as installation of windows overlooking natural settings, including urban, street trees; placing indoor plants in hallways, offices, and classrooms; and installing pictures or paintings of natural scenes. However, a drawback of this strategy that brings plant-life indoors could aggravate some students' pre-existing allergies (Miles et al., 2014).

Further, recent studies have evaluated the perceived comfort of study facilities in terms of lighting, spatial, and indoor air quality in classrooms (Hui & Cheng, 2008; Marchand et al., 2014). Incorporating elements of biophilic design in learning spaces have the potential to positively support university students, creating environments that are stress reducing, and enhance creativity and cognitive development.

Recognizing the complexity of human responses to natural environments, many geographers have employed the therapeutic landscapes framework when studying the potential health benefits of natural places (Gesler, 1992; Palka, 1999; Williams, 1999). The literature of therapeutic landscapes holds that places (whether they are considered natural or not) consist of several interacting and overlapping components—the natural environment, the built environment, the symbolic environment, and the social environment (Gesler, 1992).

Windhorst and Williams (2015) employed the therapeutic landscapes framework in a study exploring the types of natural places that 12 Canadian post-secondary students found beneficial to their mental health and well-being. They found that students preferred natural places that were familiar (symbolic environment), contained a variety of natural elements (natural environment), and were distanced from the context of everyday campus life (separated from the built and social campus environments, both of which were considered stress-filled).

While experiencing natural environments in various forms can promote mental health, these benefits may also extend beyond the immediate encounter. Using the concept of nature connectedness, a psychological construct described as the cognitive, affective, and physical connections that individuals have with the natural world (Nisbet et al., 2009), environmental psychologists suggest that we carry our relationship with nature within us as an ecological identity. Several studies suggest that nature experiences might lead both to short-term (Mayer et al., 2009), and long-term (Tam, 2013) increases in nature connectedness. A recent meta-analysis of 21 studies exploring the nature connectedness-mental health dynamic concluded that individuals who are more nature connected tend to experience more positive affect, vitality, and life satisfaction than those who are less nature connected (Capaldi et al. 2014).

However, it is important to note that related to immersion in nature, students need to make use of these offerings to have a meaningful impact. It is also important to note that there are other determinants of health relevant to young adults. If individuals do not perceive natural environments as a source of potential good (Wong et al., 2021) or do not have regular access to open space or greenery of any kind, the effectiveness of these places as a preventative health tool will decrease.

Despite the mental and physical health benefits derived from natural environments, one's feelings can be diverse (Alsop & Watts, 2003). Positive emotions however tend to be nurturing such as lifting one's mood, reducing stress, and increasing attentiveness. In what ways are natural environments on campus important to college students? Are there aspects of the built environment that can elicit similar positive emotions in the absence of nature? Our research aim was to explore these types of questions within a rural, residential, college setting.

2. Methods

This study was conducted with undergraduate college students in a small, rural university setting in southwestern New Hampshire. It is important to note that the majority of students (99%) live on campus throughout the academic year (Dougherty, personal communication, 2021). The campus is set on 1200 acres with a lake, mountain views, and nature trails. The temperature can vary greatly throughout the academic year, between 9 degrees—76 degrees Fahrenheit on average with long, cold, and snowy winters.

Nearly nine percent of the student population participated in this research including questionnaires ($n = 107$) and focus groups ($n = 71$). A team of two members of teaching staff and eight undergraduate students conducted and analyzed the data. The student researchers were part of a National Institutes of Health grant program whose emphasis is on research experiences for undergraduates. Institutional Review Board consent was obtained prior to data collection. Consent forms were used for all data collection procedures.

Our research aims were to inquire: 1. How do students perceive their overall wellbeing? 2. How do students perceive the built and natural environments of the campus in helping or hindering feelings about sense of place and consequently, themselves? 3. Are there aspects of the built environment that can elicit similar positive emotions in the absence of a natural environment?

2.1. Questionnaire

The research team created a 22-question questionnaire and administered it to 107 participants, recruiting through an all-school app (see Appendix A). There were 68 women and 39 men participating in the questionnaire. A representative sampling technique was used which included a call for participants to the entire residential community, excluding commuter students (1% of student enrollment). The goal was to obtain a subset of students that reflected a mix of demographic attributes proportionate to the student population.

The questionnaire themes were chosen by the student research assistants with guidance from faculty. Theme creation was based on a mix of students' first-hand knowledge of the population within this context as well as gaps identified in the literature (Dyson & Renk, 2006; Largo-Wight et al., 2005; Lee & Goldstein, 2016; Regehr et al., 2013; Yusufov et al., 2019). The purpose of the questionnaire was to gather student self-perceptions of general well-being to help guide the creation of focus group questions.

The questionnaire data were collected in Survey Monkey and exported and analyzed in SPSS. Nearly half of the questionnaire participants also opted to participate in one of a series of focus groups. Questionnaire results were used to develop questions for a series of in-depth focus groups to further explore how both the natural and built environments on campus could be a supportive factor in overall well-being.

2.2. Focus groups

Students were recruited using purposeful and snowball sampling from classes, clubs, sport teams, and informal peer groups for a total of five focus groups. Forty-five of the 71 students identified as female and 26 as male. "Non-binary" and "Other" were also options for gender demographics but yielded one and zero students, respectively. Students were distributed

across grade level, i.e. freshmen (22), sophomore (15), junior (20), and senior (15). Participation was voluntary and no incentives were provided. The goal of the focus groups was to explore student perceived feelings in indoor and outdoor areas of the campus. Focus groups were facilitated by a student researcher with a set of guiding questions (Appendix B). The questions addressed student experiences outdoors on campus, awareness of outdoor recreational areas on campus, self-esteem in the natural and built environment on campus, perception of an ideal campus versus reality of current campus, and barriers to spending more time in campus outdoor settings.

Focus groups were recorded and transcribed using Temi, an online transcription service. A deductive coding method was used whereby a coding guidebook (i.e. focus group questions and prompts) was developed prior to the start of focus groups to look for specific themes in the data. However, theme generation was also emergent and was integrated during analysis. Our coding structure was an iterative process to generate themes and find connections among them (Schram, 2006). A combination of hand coding and NVivo (qualitative data software) was used to analyze and organize the data. The data were qualitatively coded primarily by four members of the research team using NVIVO coding software. Inter-rater reliability was assessed with a kappa coefficient of 0.80. Data saturation was reached after five focus groups when no new themes emerged.

3. Results

3.1. Questionnaires

SPSS was used to find significant differences in questionnaire responses between groups of a specific demographic. All of the tests conducted through this software platform were performed at a 95% confidence interval (having a significance level of .05). Participants that chose “N/A” for the independent variables were excluded when that independent variable was being tested and also excluded from the analysis of that specific question. There were two areas of significance related to grade level and gender. We wanted to examine different demographics of students and determine if specific student populations differed from one another in terms of perception of well-being. Demographic differences were important to inform focus group design.

Two statistical analyses were used to determine demographic differences (given the variables in the study): a One-way Analysis of Variance (ANOVA) and post-hoc tests (specifically a Dunnett’s T3 post-hoc test). As shown in Table 1, After a One-Way Analysis of Variance is as shown in Table 2, conducted, the F value will determine whether there is a significant difference found between the groups or not. However, the ANOVA does not determine which specific independent variables differ from one another. This analysis just states that a significant difference was found when comparing all the groups. Post-hoc tests can be used after an ANOVA to pinpoint which specific groups significantly differ from one another (e.g., A post-hoc test found that seniors work more hours than freshman).

A One-way Analysis of Variance (ANOVA) was performed for all questions with three or more groups to determine if there was a significant difference found between them. A Dunnett’s T3 post-hoc test was specifically used due to the unequal sample sizes between the independent variables, the relatively small sample sizes of each independent variable measured, and the presence of significant differences in variances. These three factors ultimately led to the use of Dunnett’s T3, as other tests were narrowed down due to these reasons. To determine if significant differences existed in the variances, a Browns-Forsythe test was performed prior to post-hoc testing.

Analysis of variance (ANOVA) tests were performed when grade level was of focus. The independent variables in this demographic were freshman, sophomore, junior, and senior. The dependent variables consisted of the numbers 1–5 (disagreement to agreement) from the Likert scale given to the participants in this study. If significance was found, post-hoc testing was performed. Dunnett’s T3 post-hoc test was used in all cases applicable due to the unequal sample sizes between the independent variables and the significant differences in variances. To validate the use of Dunnett’s T3 post-hoc test, a Brown–Forsythe test was used to determine if significant differences existed between the variances. The post-hoc analyses shows where the significant difference(s) were found between the independent variables.

When examining the grade level demographic, five questions had a significant difference between all the independent variables (freshmen, sophomores, juniors, and seniors). The questions with significant differences are related to financial insecurity, low self-confidence, lack of sleep, and lack of social support.

T-tests were performed when gender was of focus as shown in [Table 3](#). The independent variables in this demographic were males and females. Non-binary was an independent variable for gender that was excluded from the analyses due to the extremely small sample size in this group ($n = 1$). The dependent variables consisted of the numbers 1–5 (disagreement to agreement) from the Likert scale given to the participants in this study. This test resulted in two significance values (one for assuming equal variances and one for assuming unequal variances) between the males and females for each question. Levene’s test of homogeneity was used to determine which value of significance should be used. When examining the gender demographic, 10 of the 23 questions found significant differences between males and females.

3.2. Focus groups

Students were asked about the indoor and outdoor settings on campus that helped to relieve their stress, where they felt best about themselves on campus, and what prevented them from spending time in natural environments. Focus group facilitators used guiding questions ([Appendix B](#)) and had a set of probing questions specifically related to the areas of significance found in the questionnaire. Questionnaire findings showed that as a student progresses through school, they gain overall confidence and have more social supports while getting less sleep. Female students, in particular, felt a stronger loss of connection to family and were not as confident in their ability to cope with college stressors. These questionnaire findings were used to inform focus group discussion.

Three overarching themes emerged in the focus group data: Indoor classroom space matters; weather contributes to time spent outside; and social interaction within natural spaces was important for female students. Students said that classrooms with natural light and a view of nature were important to feel relaxed during class and exams. Classroom temperature was also important to feel “cozy” and essentially nurtured by one’s physical environment. Temperature and a feeling of coziness was especially important to female participants whereas natural light was especially important to male participants. About half of focus group participants said they spend time outside on campus regularly. They use the campus trails to exercise (walk, run, and hike), they play an outside sport, or they sit on the lake shore. However, only mild weather contributes to stress relief. In this region, this includes the beginning of fall semester and the end of spring semester, approximately two months total. Being outdoors when it is cold or rainy contributes to stressful feelings. This was universal between male and female participants. While sitting on the campus lawn or on the shores of the on-campus lake were important to nearly all participants, female participants were especially keen to hang out with friends to “get fresh air” and “feel a sense of peace” and “forget about life’s worries.” However, female students were less likely to spend time outside alone so weather and friendship were important determinants in using natural environments to de-stress. One female student reflected on her weekly bird-watching walks

with a classmate while another described a spot near the campus pond that she and her friends go to when life gets overwhelming.

Indoor spaces were places for first-year students to find new connections and create the right atmosphere for studying and for female students to strengthen their interpersonal relationships in a comfortable setting. Seniors slept better in residential housing that they believed felt optimal. The biophilic design element of promoting a feeling of refuge was particularly important. Students were creating their own sense of refuge. The following are selected quotes from students about the feelings that result from nurturing indoor spaces.

“I try to recreate that winter camping feel inside my dorm room. I don’t close the curtains at night so that I can (maybe) see the stars. I cuddle inside my sleeping bag.”

“Having a nice comfy room with a soft rug and chairs for you to sit on as well also a window letting you see outdoors when the sun is shining, or the rain is coming down.”

“Cozy space where I can cuddle up when it is cold out and read and just be happy.”

“My ideal indoor setting is either on my couch or in my bed with lots of comfy blankets, in sweats, watch TV or a movie, and its warm.

“My mom bought me this great rug that is like sleeping on a bed of moss. It’s so soft and comfy.”

This importance of natural environments extended into the classroom as well. Introduction of daylight into all occupied spaces can establish the biophilic pattern of connection to natural systems and provide more productive workspaces (Peters & D’Penna, 2020). Theorists recommend that every classroom should either have windows on the exterior facade of the building or, if that is not possible, windows that look into an atrium that brings natural light into the space.

Lighting variability throughout a day includes the use of diffuse light, circadian light, and colored light in order to stimulate student learning. Variability of lighting throughout a classroom could stimulate engagement and vary the experience for class activities (IESNA, 2000; Karlen & Benya, 2004). Students in the focus groups concurred with this approach. Freshmen and sophomores felt that they could concentrate more fully in classrooms that used natural lighting.

“I like having the windows open up to let some sunlight in or just look outside.”

“If it isn’t warm out I’m not a fan of being outside but seeing the outside through windows and getting natural light helps to release stress.”

“I like having classes in this room. I like that its warm and bright. I don’t like the uncomfortable chairs”.

“I like that there are plenty of windows in this room not only allowing sunlight in but allowing students to look out at the mountain for a moment if they so choose.”

Extending beyond bricks and mortar, a university should provide the options to conduct certain activities either outside or inside. A recent study evaluated the preference and perceived restoration likelihood of outdoor university spaces for study breaks, restoration, and socializing (Van den Bogerd et al., 2018). The outdoor space that had built seating and extensive greenery was the most preferred as opposed to the same space without greenery

or the same space with colorful artifacts. Provision of outdoor eating spaces, lounge spaces, study spaces, and potentially even outdoor classrooms will naturally enhance nature connectedness in students and improve connection to place.

Facilitating place attachment in areas that might feel less central or secure on campus can also help encourage students to utilize those spaces. When the edges of a campus seem to bleed into the surrounding environment, students may not have a strong sense of place in those areas. A study of the transition from home to a university campus described security and expression of the aesthetic of place as comforting factors for new students (Chow & Healey, 2008). Potentially using the spaces at the outer areas of campuses as landscapes, gardens, cultural spaces, or social spaces can help create a sense of purpose and place in a space that is otherwise uncertain or uncomfortable.

“Well, it’s quiet outside here (away from the center of campus). It’s just the air feels cleaner outside, so I just go out and take a nap on the grass or just sit there. Me and my roommates actually do that. Like on the warmer days, we’ll literally go have our breakfast outside on the hill, like with a blanket or something. Having the sun on you is so relaxing and so peaceful. Eases your mind. Nice.”

4. Discussion

The questionnaires yielded insight into the perceived well-being of college students. The focus groups complemented the questionnaires and provided data into how the natural and built campus environment was perceived to both mitigate stress and restore well-being. Students provided recommendations to improve outdoor and indoor experiences and ways higher education administrators could improve access to and participation in the natural beauty the campus and beyond offered. Insights could be offered to other college campuses as well.

The questionnaires informed us that as a student progresses through college, they take on more responsibility such as employment. More work and higher level courses may impact sleep. However, over four years confidence and resiliency has grown; enabling students to better cope with college stressors. This is consistent with other studies that show that maturation during college includes a stronger sense of self, belief in oneself, and confidence to handle additional stressors (Davidson et al., 2012).

The questionnaires also informed us that female students were feeling a loss of connection with family members. They were not as confident in their coping abilities as male students. Female students also tended to remain strongly connected with their mothers and relied on her for daily support. Feelings of a loss of connection with family may have led to a loss of a strong sense of self as that sense of self is relational and firmly tied to family. Therefore, this research poses two further questions: How might the built and outdoor campus environment support freshmen and sophomores to start off college with more confidence? How might the built and outdoor campus environment support female students to feel more socially connected and confident in their coping abilities?

The University put in a few indoor and outdoor seating areas and these were shown to be very popular with all students, but they are insufficient according to our participants. Students want intimate spaces throughout the campus to feel like they are “somewhere else.” Freshmen in particular want spaces where they feel figuratively “held.” They expressed particular fondness for the campus hammocks as places to be away from new social pressures. Female students appreciated the new sitting area outside of the library café including a couple of chairs and a fire pit. This area became their meeting ground to reconnect with friends between classes as it is situated in the center of campus.

The focus groups revealed that all students are feeling a range of emotions such as “overwhelmed,” “tired,” “anxious,” “confused,” “frantic,” “worried,” “exhausted.” They also revealed the positive impact of views of nature or being immersed in nature given the right conditions both in class and in the residence halls.

5. Conclusion

With the unprecedented increase in rates of mental illness and stress with a concurrent reduction in regular contact with traditional supports, e.g., friends from high school and family colleges and universities have an opportunity to explore alternative methods to ameliorate the impact. Both natural-areas immersion and biophilic design hold promise in mitigating stress related behaviors in college students and providing restorative spaces for learning and self-growth. Colleges & universities can take advantage of nature inspired themes with flora, lighting, artwork, and airflow, etc. to positively support students; creating environments that are stress reducing, and enhance creativity and cognitive development.

Students on our residential campus spend nearly all of their time within the property boundaries. The campus is a place that has a mix of environments: the symbolic environment, the natural environment, the built environment, and the social environment. All of these environments have the potential to hold meaning for students. When these different environments are felt as nurturing, such as through biophilic design, they become therapeutic. We heard students describe how they were creating their own nurturing, therapeutic spaces inside that matched the feelings evoked from their time outside.

5.1. Future opportunities

Biophilic design reworks the built environment to purposefully connect and engage people with nature and one another (Beatley, 2011; Soderlund & Newman, 2015). Natural features are incorporated into the built environment with consideration of our evolutionary needs and tendencies to affiliate with the natural world. Kellert and Calabrese (2015) define specific features central to biophilic design that include promoting engagement with natural environments, using natural environments to improve one’s health and fitness, and establishing a built environment that is visually and emotionally appealing, physically accessible, practical, and engages all the senses. Browning et al (2014) identify 14 patterns in biophilic design. These can be as simple as planting urban trees in view of classroom windows, using photography of natural scenes in classrooms without windows and encouraging the use of natural lighting in public, indoor spaces. This is especially important in places where colder weather may be prohibiting outdoor recreation. Layered on top of these physical changes are what Browning et al. (2014) consider the nature of the space. What kind of hopes does a space give or provide? Is a space a retreat? Is a space safe? For female students, being with others while outside offered a level of protection, a stronger feeling of safety.

Finally, post-secondary institutions can increase student interactions with natural environments by simply raising awareness among their student populations about the potential mental health benefits of connecting with local natural places. The specific format that an awareness campaign might take is quite flexible. Colleges and universities could choose to include this message either as a part of existing mental health promotion activities, or through stand-alone campaigns. Drawbacks to this strategy include that awareness-raising does not necessarily translate into behavior change among students, and, as Windhorst and Williams (2015) discovered, some students may consider the campus setting and surrounding environment stressful—preferring instead to visit familiar natural places further removed from the post-secondary milieu.

The participation of undergraduate researchers was a strength of this study. Students participated in every aspect of the research project and reported significant learning outcomes related to

perseverance, resiliency, and team-building among other. Limitations include a small sample size and single case-study setting.

Further research is needed to learn how biophilic design in classrooms and residential housing can be used to support female students in their abilities to cope and to strengthen their sense of self in the face of outside stressors. Natural environments can be nurturing at a time when female students are away from family. The right room or weather conditions can provide physical and emotional support. More research is needed on the connection between stress and gender on this campus and the ways in which more spaces can be created to be supportive. Further research is also recommended on the ways in which students experience natural environments differently on campus and to what extent nature is accessible to them physically and emotionally.

Also, further research can look at how best to use natural environments to create nurturing learning spaces so that the challenges associated with college can be met with confidence because there is time and space to essentially, relax. With so many college students experiencing disengagement, the physical design of a college and the connection to its natural surroundings has the potential for profound change.

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Author details

Verna DeLauer¹
E-mail: delauerv@franklinpiercedu
Andrea McGill-O'Rourke²
E-mail: mcgillorourke@hussonedu
Tyler Hayes²
E-mail: Hayest16@live.franklinpiercedu
Ashley Haluch²
E-mail: Halucha17@live.franklinpiercedu
Carissa Gordon²
E-mail: Gordonc16@live.franklinpiercedu
Julia Crane²
E-mail: Cranej17@live.franklinpiercedu
Dena Kossakowski²
E-mail: Kossakowskid18@live.franklinpiercedu
Carina Dillon²
E-mail: Dillonc17@live.franklinpiercedu
Nicole Thibeault²
E-mail: Thibeaultn17@live.franklinpiercedu
Daniya Schofield²
E-mail: Schofieldd16@live.franklinpiercedu
¹ Franklin Pierce University, Rindge United States.
² Husson University, Bangor United States.

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Appendix A Questionnaire

For the following questions, please mark your answer on the given scale.

(1) My involvement on campus (not including classes, but including work, athletics, clubs, etc.) per week:

- 1: 0–1 hours
- 2: 1–3 hours
- 3: 3–5 hours
- 4: 5–7 hours
- 5: 7+ hours

(2) I am taking:

- 1: 12–14 credits
- 2: 14–15 credits
- 3: 15–16 credits
- 4: 16–17 credits
- 5: more than 17 credits

(3) Per week, I get ___ hours of physical activity (including athletics):

- 1: 0–1
- 2: 1–3
- 3: 3–5
- 4: 5–7
- 5: 7+

(4) Per week, I spend ___ hours outside (including athletics):

- 1: 0–1
- 2: 1–3
- 3: 3–5
- 4: 5–7
- 5: 7+

(5) Per week, I work ___ hours. [answer if employed]

- 1: 0–2 hours
- 2: 3–5 hours
- 3: 6–8 hours
- 4: 9–11 hours
- 5: 12+ hours

(6) My job causes me stress. (If unemployed, mark *neutral*.)

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(7) I feel secure in my/my family's financial status.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(8) Being away from home for long periods of time causes me anxiety or stress.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(9) I have a strong/positive sense of self-esteem.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(10) I have healthy coping mechanisms for coping with my stress (ex: I have an outlet for my stress, I see a therapist, etc.).

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(11) I am in a healthy, happy relationship (romantically).

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(12) I am comfortable in my body and have a positive body image.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(13) I am confident in myself and my abilities.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(14) I lead a healthy lifestyle (eat well, get physical activity, get a good amount of sleep, etc.).

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(15) I get a healthy amount of sleep each night (recommended for adults: 7–9 hours nightly).

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(16) My close family and friends are healthy and doing well.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(17) I have lost somebody close to me in the past year.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(18) I get along with my roommates.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(19) If I live with two or more roommates, my roommates get along with each other. (If you only live with one roommate, mark your answer as neutral.)

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(20) I feel like I can't keep up with all of the things I have to do.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(21) I feel like I am on top of things.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

(22) I often feel angry or anxious about things that are out of my control.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

Appendix B Focus Group Questions

- (1) I'd like to go around the room and have everyone name one word to describe their state of mind in the moment.
- (2) Once everyone shares, ask: how does the space we are in now make you feel—are you comfortable, what do you like/not like about it?
- (3) Tell me a little bit about what you do to relieve stress indoors and outdoors on campus?
- (4) Do you associate being outdoors on campus with stress release? Why/why not?
- (5) Do you have any particular negative or positive experiences outdoors while on campus?
- (6) Where do you feel your best self on campus?
- (7) Describe your ideal outdoor setting on a college campus.
- (8) Describe your ideal indoor setting on a college campus.
- (9) Are there any outdoor or indoor spaces at FPU that meet this ideal? If so, how?
- (10) Is there anything that keeps you from spending more time in nature?
- (11) Are you aware of the campus trails? Have you ever been on them for any reason other than for a class?

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