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A Conceptual Framework for Campus Green Spaces Supporting University Students' Socio-Emotional Well-Being

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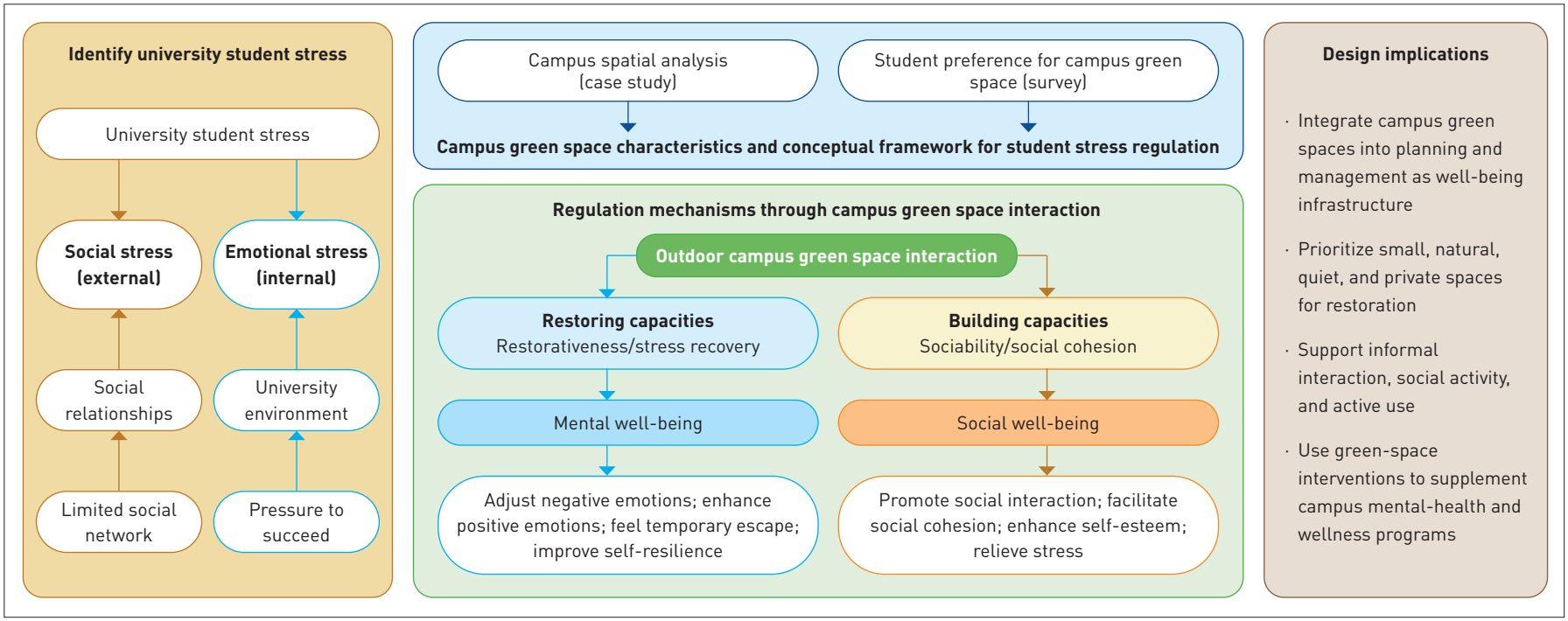
GRAPHICAL ABSTRACT



ABSTRACT

Many university students experience stress and anxiety due to life-transition demands that affect their psychosocial health. Campus green spaces can serve as nature-based interventions to reduce student stress and improve socio-emotional well-being. This research identifies specific campus green space characteristics as nature-based therapeutic mechanisms that support positive spatial associations between student stress reduction and campus green space interaction. A student survey assessed perceptions of stress, stressful periods, stress-relief behaviors, and preferences for campus green space conditions, types, and potential interactions that may mitigate stressful feelings. Students reported that smaller outdoor spaces designed for social activities and physical exercise were most preferred, whereas larger social spaces were less so. Preferred green space characteristics included naturalistic, smaller spaces that feel peaceful and quiet and offer privacy, whereas the least preferred spaces were single-function sites. These results provide insight into students' current and preferred relationships with stress-mitigating campus green spaces and can inform

improved spatial configurations. A case-study spatial analysis and conceptual illustrations communicate the results through evidence-based design. Students' emotional and psychosocial well-being is key to their transition into future careers and their interpersonal capacity to manage life situations. Strategically designed and managed campus green spaces can help regulate students' stress levels during the semester and support academic success.

KEYWORDS

University Student Stressor; Socio-Emotional Well-Being; Campus Green Space; Landscape Preference; Evidence-Based Design Research

HIGHLIGHTS

- Students prefer natural, quiet, small, and enclosed green spaces for stress relief
- Identifies greenspace features supporting student well-being and stress reduction
- Proposes design strategies that reduce student stress through spatial interaction

1 Introduction

University students are at increasing risk of mental health problems, and universities are struggling in their efforts to respond. The prevalence of mental health-related problems and well-being concerns, including stress, psychological distress, and symptoms of mental illnesses, continues to increase among Canadian postsecondary student populations[1]. Excessive stress in this population has been linked to a number of negative academic and health outcomes. Universities worldwide have spent considerable time and money implementing student well-being measures in the past decade[2–3]. Despite attempts to improve mental health at postsecondary institutions, a persistent gap remains in evaluating specific sources of student stress within postsecondary settings and in exploring non-treatment alternatives related to outdoor space interaction for such population.

1.1 University Students, Transition, and Stress

University life is a transition period; many university students face significant challenges, including current and new relationships, lifestyle changes, a new environment, academic performance, financial pressure, and unknown future outlook. Additionally, university students were uniquely affected by the COVID-19 pandemic and are considered in states of post-traumatic stress disorder (PTSD)[4]. They suffer more stress than they did during adolescence as they adapt to an unfamiliar environment[5]. This period is considered one of the highest anxiety and lowest mental well-being phases in the life cycle, with high levels of psychological distress compared with the overall population[6–7].

Stress is any demand placed on people's brain or physical body. It can be triggered by any event or scenario that makes people feel frustrated or nervous. Too much stress can leave people in a permanent stage of "fight," making them feel overwhelmed or unable to cope[8]. Long-term, unmanaged stress can interfere with people's daily life and take a toll on mental and physical health[9]. Over prolonged periods of stress, the human body becomes overwhelmed, affecting the capacity of each system and causing physical and psychological reactions such as loss of appetite, tense muscles, insomnia, depression, and fatigue, which can ultimately lead to further disease.

In a recent study, less than half (45%) of university students rated their overall health as "very good or excellent" while about 30% of students experienced clinical levels of depression[10]. In 2019, over 60% of surveyed Canadian students reported above-average stress within the past 12 months (on an adjectival five-point scale ranging from "no stress" to "tremendous stress"), while 69% reported "overwhelming anxiety" and 52% reported feeling "so depressed it was difficult to function"[11].

Research shows that students experience emotional and psychological distress while adjusting to college[12]. This can occur because of new and the greater expectations while attempting to navigate new social and academic settings and increased responsibility[13]. University students often suffer from a low self-image or low self-esteem[14], resulting in anxiety, reduced self-value, depression, and loss of confidence accompanied by more passive behaviors[15]. Anxiety and depression are common, particularly in the first year, and are damaging to academic and social participation[16].

Acquiring a post-secondary education can be exciting, transformative, and demanding. Research on the relationship between stress and well-being has reported that university students experience stress in many aspects of campus life, including

academic output, financial concerns, employment requirements, identity, and interpersonal relationships[17–20]. Although each student's experience differs, these challenges generally fall under the following categories per a recent Canadian study[21]: adjustment to post-secondary lifestyle respond to academic performance expectations, new campus and social culture, concern for future employment, and changes to core relationship support.

Student stress results from all these components. During adjustment to the university setting, students experience many changes to their physical environment in addition to an increase in academic expectations and workload. Food and nutrition intake often changes, and healthful behaviors such as sleep and recreation are also negatively affected[22]. Academic performance standards may increase considerably when students enter university, resulting in academic stress, which is often associated with poor mental health in Canadian students[23]. For first-year students, this stressful transition may be most acute; stressors include the amount and newness of coursework, new completion timelines, fear of failure, and lack of motivation[24]. Transitioning into the university environment also brings academic and social integration pressures, such as fitting into campus culture and new social spaces[25]. International and Indigenous students face racism and other prejudicial attitudes at Canadian universities[26], which has resulted in higher stress levels and poorer mental health[27]. Additionally, concerns about campus safety have been reported to negatively affect academic performance and mental health[28–29]. A sense of campus community, or belongingness, has been shown to be an important predictor of students' overall well-being in terms of psychological health and social support among students in the United States[30] and Canada[31]. A Canadian study reported that one of the most common reasons university students visited campus counselling centers was their concern about having a job after graduation[32]. Students' future anxiety has been shown to negatively affect their overall self-confidence[33]. The transitional stressors surrounding concepts of student identity are summarized in Fig. 1.

Although stress affects the three primary well-being domains—physical, social, and psychological—differently for all students, this study focuses on students' socio-emotional well-being. Socio-emotional well-being is generally understood as one's ability to understand and manage emotions and to form social connections and relationships. More specifically, it is "a general and relatively stable emotional state that indicates the emotional evaluation, positive or negative, that an individual makes of the results of the totality of his/her social interactions"[34]. Sometimes referred to as psychosocial well-being, socio-emotional well-being synthesizes

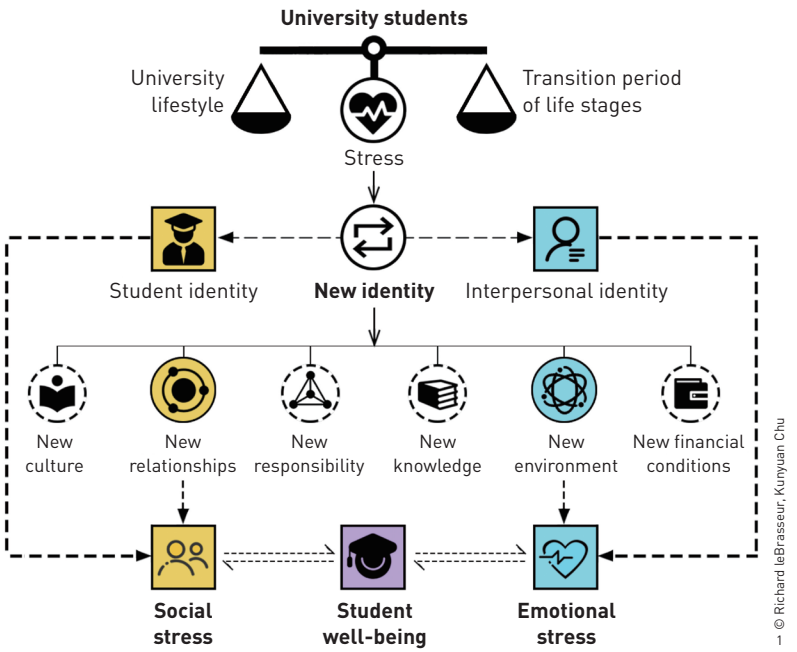


Fig. 1 University student identity stressors.

external (social) and internal (psychological) influences while recognizing emotional states as the key construct related to socio-emotional well-being and life satisfaction, according to theoretical models including Daniel Goleman[35], Reuven Bar-On[36], and recent university-based studies[37–38].

The concepts of socio-emotional well-being, social well-being, and emotional well-being are related but distinct; each describes different aspects of human health and functioning, particularly in psychology, education, and health sciences. Emotional well-being refers to an individual's internal emotional state, including how people feel about themselves and life in general, their ability to manage emotions, and their capacity to maintain a sense of balance[39]. Social well-being involves the quality of a person's relationships and interactions within the society. It reflects how well they connect, contribute to, and feel accepted by their social environment[40]. Socio-emotional well-being, as a combined concept, refers to a person's ability to understand and manage emotions, build positive relationships, and navigate social environments effectively.

Six specific social and emotional stressors were identified for university students (Fig. 2). Social stressors develop due to a lack of social relationships impacted by limited opportunities for social interaction, the low quality or "newness" of those social relationships, and the accompanying desire for social performance or admiration by a new peer group. Emotional stressors occur due

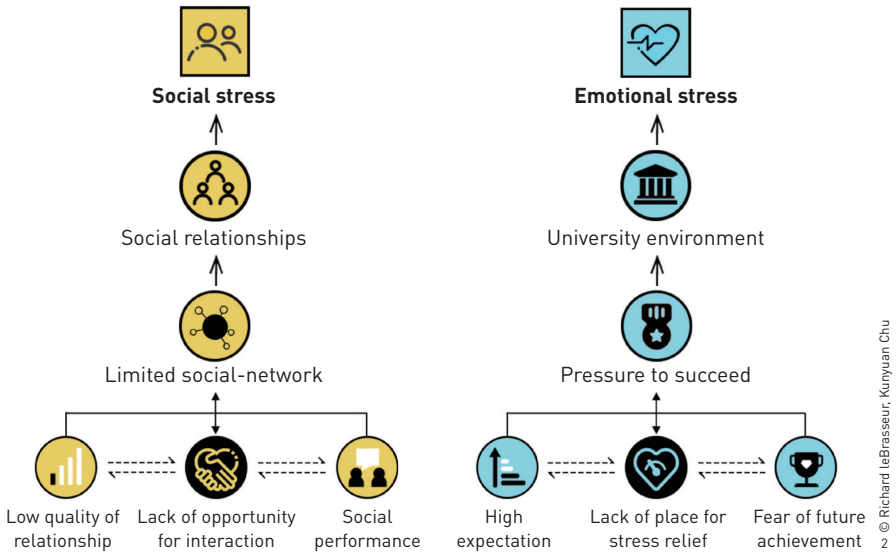


Fig. 2 University students' social and emotional stressors.

to the university environment's implied pressure to succeed. These internal and external stressors are embedded due to a perceived lack of appropriate environments to relieve psychological and emotional stress, high expectations for academic achievement, and fear of future career failure.

It is important for students to adjust personally, emotionally, socially, and academically to continue in their college career, and the university environment should offer spaces for this adjustment and growth. Many educational institutions have adopted a more comprehensive, socioecological understanding of health, recognizing that dynamic interactions between personal and wider environmental factors shape well-being[41]. However, an important health resource is still widely overlooked, namely campus green space[42].

1.2 Student Stress and Campus Green Spaces

Campus green spaces are essential health-promoting resources in everyday university life for student, faculty, staff, and the larger community. Campus green spaces mitigate socio-emotional stress through contact with "nature" or green spaces. Two mechanisms link campus green space to well-being: restoring capacities and building capacities. Restoring capacities provide emotional stress relief through the neurobiological effects of green space interaction[43–44]. Building capacities, conversely, provide social stress relief through green space social interactions and its modalities towards social cohesion[43].

Numerous studies have demonstrated that both direct and indirect contact with green space have positive effects on health, particularly for stress reduction[45–49]. The effects of green space on stress relief operate through one or more of three primary mechanisms: 1) physical activity which, in turn, improves mood[50]; 2) social contact and the sense of "belonging" within a community[51–52]; and 3) psychological and emotional restoration related to attention processes and relief of fatigue[53]. Physical activity has been shown to improve aspects of mental well-being in addition to physical health. For example, sedentary and light-activity students experienced significantly more stress than those doing moderate activity[17].

Additionally, campus green spaces can improve a student's overall well-being and reduce social stress by building sociability and meeting students' needs for social contact. The theoretical positions for social green space benefits encompass interaction, social cohesion[54], and social identity[55]. Outdoor campus green spaces facilitate social stress relief by creating areas for planned and spontaneous activities in a natural setting[56], encouraging student engagement with outdoor social activities[57], and enhancing interactions among students and faculty[58], thereby promoting social relationships[59]. Campus green spaces also create a sense of belonging for students[60], fulfill students' needs for social contact[61], and provide space for close social relationships that serve as an outlet for negative moods[62]. Campus green spaces can increase constructive interpersonal relationships and social inclusion[63], arouse interpersonal or social interests, and alleviate tense nerves[56].

Psychological restoration is related to recovery from stress and primarily includes stress-related physiological and mental symptoms; it allows one to adjust emotional states[64] and is closely related to emotional stress relief[65]. Two complementary theoretical positions of restorative environments guide this relationship. The first, Stress Recovery Theory (SRT), is a psycho-evolutionary theory postulating that natural elements can trigger an immediate affective response through the brain and neuroendocrine system[66]. The second, Attention Restoration Theory (ART), centers on a psycho-functionalist perspective through which natural environments are inherently rich in stimuli and invoke involuntary attention that supports recovery from mental fatigue and restores cognitive function[64]. Both well-researched theories indicate that naturalistic campus green space interactions, passive or active, can reduce mental fatigue, restore cognitive function, and improve concentration in university students[67–68].

Overall, outdoor campus green spaces provide socio-emotional stress relief through multiple pathways. Interactions with campus

green spaces can adjust the negative emotions associated with stress: they help students "calm down"[69], avoid aggravation from pressures[70], reduce negative emotions[71], increase positive emotions[72], reinvigorate optimism about university life[73], improve feelings of self-confidence[74], and promote academic achievement[75] (Fig. 3).

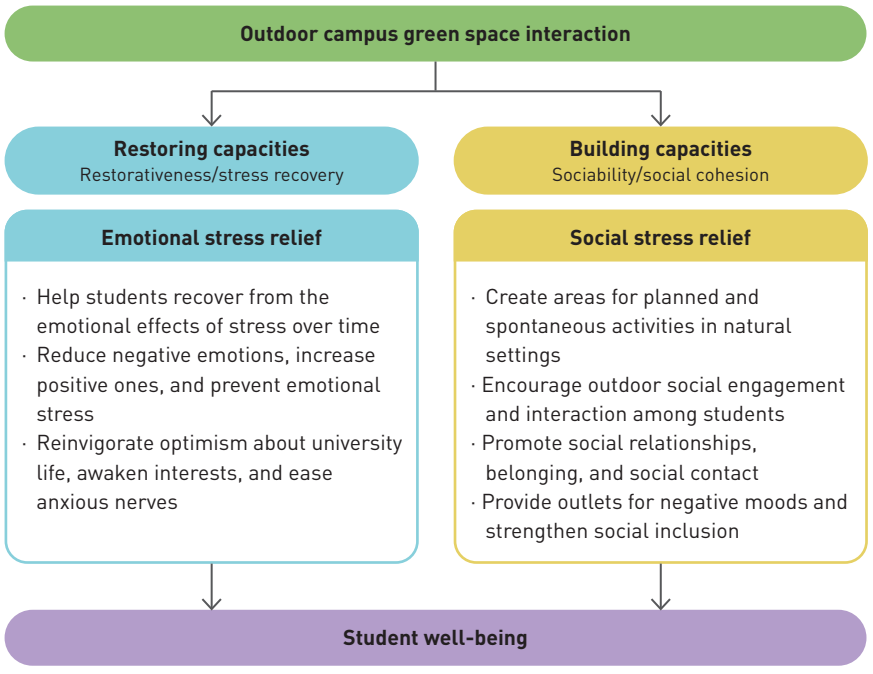
Students have reported a higher quality of life ranking when the university is perceived to have high levels of greenness or density of vegetation[76] as well as those who reported higher frequencies of outdoor interaction[77]. Similarly, a number of studies have evaluated the relationship between campus landscape types and student activities. One such study found that blue spaces surrounded by greenery offered the greatest combined benefits for mental, physical, and social well-being. In contrast, grey areas with minimal vegetation were the least favored by students[78]. In a German study by Julia Foellmer et al.[62], students' negative moods were experienced less frequently and happiness and calmness were felt more strongly in a campus's large, central green space.

However, an important question remains: how can outdoor university green spaces be better designed or programmed to provide these specific benefits? As shown in prior research, the mechanisms by which green space interactions could positively affect the psychological and/or physiological well-being of university students are varied. Most studies focus on centrally located green spaces, such as the campus green and visual levels of greenness[79–80]. A first step toward answering this question is to better understand factors surrounding student stress, current interaction behaviors, and preferences for campus green spaces and their specific spatial characteristics.

This research completed an exploratory study of students to collect baseline socio-emotional data through which green space design interventions could be founded. This is important for two reasons: first, the survey data were used to identify common socio-emotional stressors and when they are most prevalent during the semester; second, the survey identified which spatial characteristics and interactions are most preferred for relieving stress in campus outdoor green spaces. A complementary output goal was to determine conceptual campus landscape spaces or design interventions that specifically improve student socio-emotional well-being. Results provide insight into students' current and preferred relationships with stress-mitigating campus green spaces and offer a strategic framework for spatial design interventions.

In order to meet these objectives, further questions must be answered. 1) What are the most salient stressors to these students in the campus environment? 2) How do students currently interact with existing campus green spaces to reduce stress? 3) What types of and qualities within campus green spaces do students prefer to interact with for reducing stress? And 4) how can the results be synthesized to generate a series of conceptual designs illustrating beneficial spatial interventions?

Fig. 3 Campus green space restoring and building capacities for emotional and social stress regulation.



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2 Materials and Methods

The study was conducted at the Agricultural Campus of Dalhousie University in Truro, Nova Scotia, Canada. The campus is located on the periphery of a medium-sized suburban town (population 13,113 in 2022) and includes approximately 27 acres, of which 52% is considered green space within the campus boundaries (Fig. 4). The campus is adjacent to a wooded multi-use trail to the south, the Cobequid Trail, which connects the campus to the downtown and larger community.

The spatial analysis required a series of discrete maps to contextualize the existing campus green spaces, focusing on their function, circulation, and general green space qualities. Student data collection included direct and indirect methods: direct data were collected through a student survey, and indirect data were drawn from readily available university information. These data were used to generate simple statistical and descriptive



Fig. 4 Orthophoto of the university, with the study area outlined in red.

ranking analyses. After a short introduction and definition of university student stress, a 10-question survey was administered to assess student perceptions of stress, stress-relief behaviors, and preferences for campus green space interactions that mitigate stressful feelings and improve socio-emotional well-being.① To meet the research objectives, the survey did not focus on students' current stress levels, pre- and post-intervention analysis, or subjective well-being analysis. Because it is generally accepted that most university students experience stress, this survey identified only respondents' most salient stressor and the greatest and least stressful periods during the semester.

The survey did not assess student interaction frequency, barriers to use, or perceived benefit from campus green space interaction. An iterative process was used to develop the survey tool: drafts were reviewed by students and content experts on campus. The final survey and consent form were approved by the University's Ethics Board and administered electronically using SurveyMonkey for 3 weeks from October 1 to October 22, 2025; the survey was distributed to the student population by email, and instructors were asked to administer it during class time. The anonymous survey included discrete multiple-choice statements, and did not ask for demographic information such as gender, nationality, or age, as this information was collected post hoc.

3 Results

3.1 Student Profile

The following results are based on the average annual student enrollment from 2015 to 2022, 848 in total. Demographic results indicate that 65% identified as female, 34% as male, and 1% as other. Among these students, 76% were permanent residents of Canada and 24% were international students. Overall, 69% lived off campus rather than in campus residence halls (31%). The highest percentage of students were in their first year (40%), followed by second year (23%), third year (15%), fourth year (13%), and graduate students (9%). No analyses of relationships between the student profile data and the survey responses were conducted because the two datasets were collected separately. This information provides only an overview of the student population.

3.2 Student Survey

The survey and spatial analysis results identified existing and proposed mechanisms that enable university student stress mitigation and improve socio-emotional well-being through campus green space interaction. These questions were adapted from the Perceived Stress Scale (PSS)[81], the University Stress Scale (USS)[82], the College Student Stress Scale (CSSS)[83], and the Lakaev Academic Stress Response Scale (LASRS-2)[84], which measure stress across four domains: affective, behavioral, cognitive, and physiological.

There were 217 individual student respondents, and the questionnaire generated quantitative data. Question 1 asked students what caused them stress. Students reported that the most common stress-causing feelings on campus were "the concern about the unknown future or future achievement" (25%), "worry you can't cope with everything you have to do" (19%), and "too high expectation of academic performance" (19%). The least stress-causing feeling was "feel nervous about social activities or interacting with strangers" (10%).

Question 2 asked students to identify the semester period with the highest student stress, results indicating weeks 11–12, the week before final exams, followed by weeks 6–7, during mid-term exams. Question 3 asked students to identify the lowest-stress periods, results indicating weeks 3–5, during the early semester after students had physically relocated and experienced the new schedule, and week 8, when the semester break occurs. Figure 5 places these results within a curve in which student stress-level results were categorized into common measures in existing literature: stress overload (Question 2 ≥ 20% responses, SD = 59), stress underload (Question 3 ≥ 20% responses, SD = 52), and optimum stress (Question 2 < 20% and Question 3 < 20% responses)[85]. No specific student biometrics were taken. These three stress levels were adapted from literature including A. T. Welford's model of performance[86], Lennart Levi's stress

① The full survey is provided in the supplementary materials, which contains Questions 1–10.

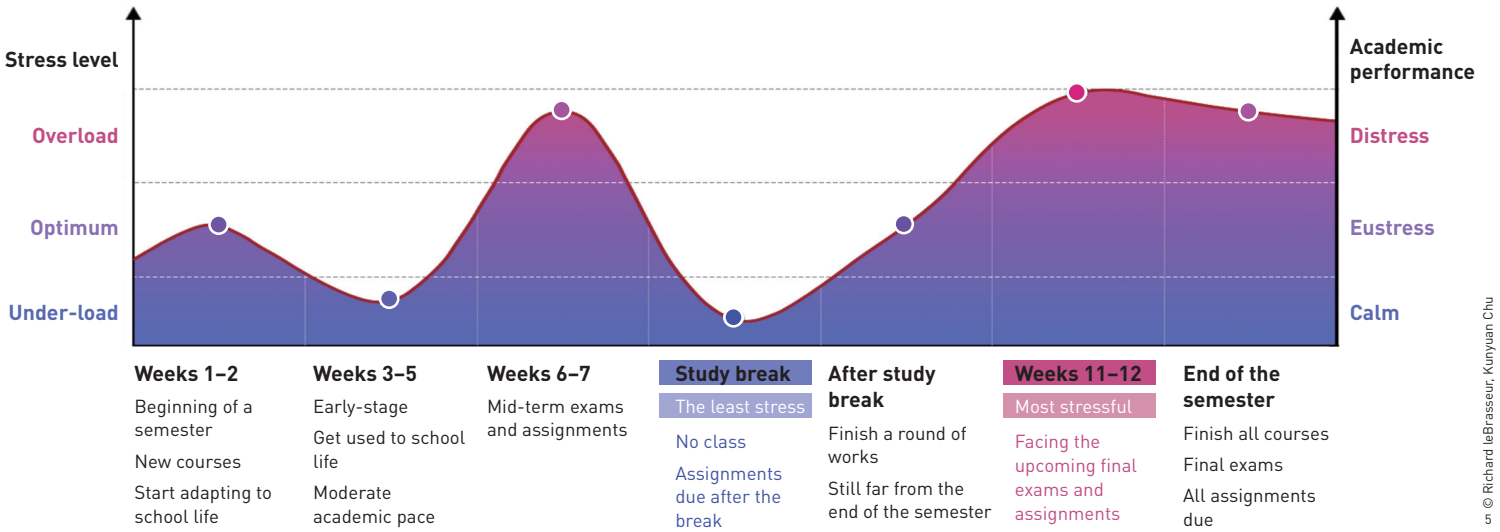
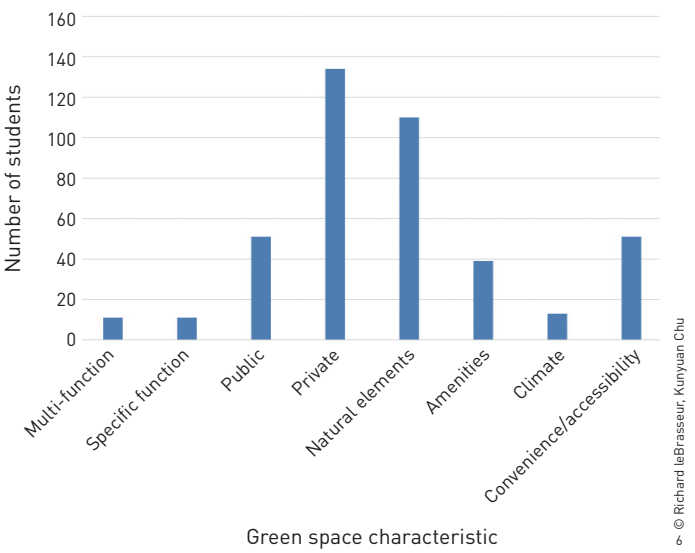


Fig. 5 Student stress curve during the semester.

responses[87], and Yerkes-Dodson theory[88], or the inverted-U model of arousal, to capture student stress phenomena. Academic performance is best at a moderate, optimal level of stress; it declines when stress is either too low (underload) or too high (overload)[85]. These three categories were ordered broadly based on a simple cluster analysis.

Questions 4–10 allowed for multiple responses per question from each of the 217 individual students. These six questions, overall, asked for student perceptions and preferences in improving and creating campus green spaces to regulate socio-emotional stress. Results from Question 4 indicated smaller outdoor spaces designed for social activities (35%) and outdoor physical exercise (34%) were most preferred, whereas larger social spaces for large groups were least preferred (9%). Additionally, based on results from Question 5 (Fig. 6), preferred green space characteristics to meet socio-emotional stress needs included natural elements (31%), private spaces, i.e., green spaces smaller in size which feel peaceful and quiet and offer a sense of privacy (25%), and multifunctional spaces with moveable tables, chairs, and overhead shelter (12%), whereas the least preferred characteristics was specific function, such as a horseshoe pit area (3%).

Based on the results of Question 6, students also noted that there were not enough outdoor study spaces (31%) or outdoor exercise spaces (22%) on the existing campus. Based on the results of Question 7, students most preferred to see outdoor social spaces such as an outdoor café, outdoor theatre, and outdoor eating areas (23%); outdoor healing spaces such as meditation or sensory gardens (19%); and outdoor natural spaces such as a campus forest or green roof areas created on campus to help relieve stress (15%). As shown in Fig. 7, the least preferred options for relieving



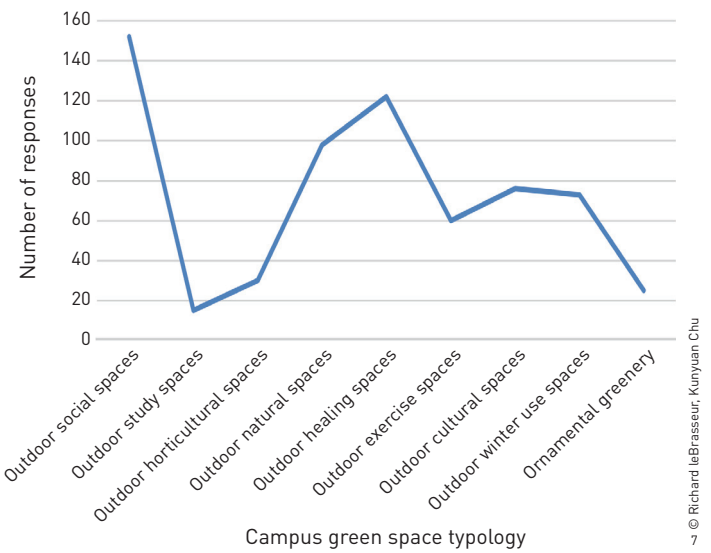


Fig. 6 Students' preferences for green space characteristics.
Fig. 7 Students' preferences for campus green space typologies to relieve stress.

stress were outdoor study spaces such as classrooms and learning amphitheatres (2%) and additional ornamental greenery such as street trees, planting areas, and turf lawns (4%).

Based on the results of Question 8, students overwhelmingly preferred "natural" outdoor campus green spaces (81%) over more "urban" green spaces (i.e. those with features such as benches and paving) (19%) for stress relief. They also preferred these green spaces to be small, intimate, and separated from other campus spaces (63%) rather than highly visible, larger, and physically connected to other campus spaces (37%), according to the results of Question 9.

Thematically, students felt that activities for stress relief were more important than specific green space characteristics. Figure 8 indicates that "activities to relieve stress" and "preference activities" have the strongest influence on student engagement with campus green spaces, while typological preferences are less pronounced. This suggests that functional and experiential aspects of green spaces are more important than categorical typology.

Overall, students exhibited a stronger preference for solitary and nature-based green spaces than for social or event-based outdoor settings, emphasizing the restorative function over the performative function of campus landscapes. They also valued both moderate social interaction and physical activity for stress relief. Across categories, students prioritized nature-integrated, semi-private, and activity-supportive green spaces, while physical engagement and quiet restoration dominated over large social events.

3.3 Spatial Analysis of Campus Green Spaces and Student Interaction

The spatial analysis synthesized the existing campus green spaces, documented their spatial characteristics, and outlined campus circulation flows specific to students' core daily routines (Figs. 9–12). The following tables and maps provide the framework for future design interventions and stress mitigation strategies within the study's conceptual illustrations (Figs. 13, 14).

Campus core area includes the central campus green space and identifies buildings to determine three primary areas important to student mobilization (Fig. 9): the student living area, the comprehensive education area, and the specialized education area. This map also identifies the campus's priority circulation flows and walking-distance times.

More detailed circulation analysis reveals distinct pathway and road hierarchies that enhance or impede students' daily movement between the three academic core clusters (Fig. 10). Student flow within and between these spaces and clusters was important to future design interventions.

The next step in the spatial analysis assessed existing green space characteristics in terms of their ability to provide social and emotional stress-relief benefits and identify future intervention opportunities. Figures 11 and 12 provide photographs of the existing campus green spaces and their qualities.

This study did not include a Normalized Difference Vegetation Index (NDVI) analysis or complete a typological classification

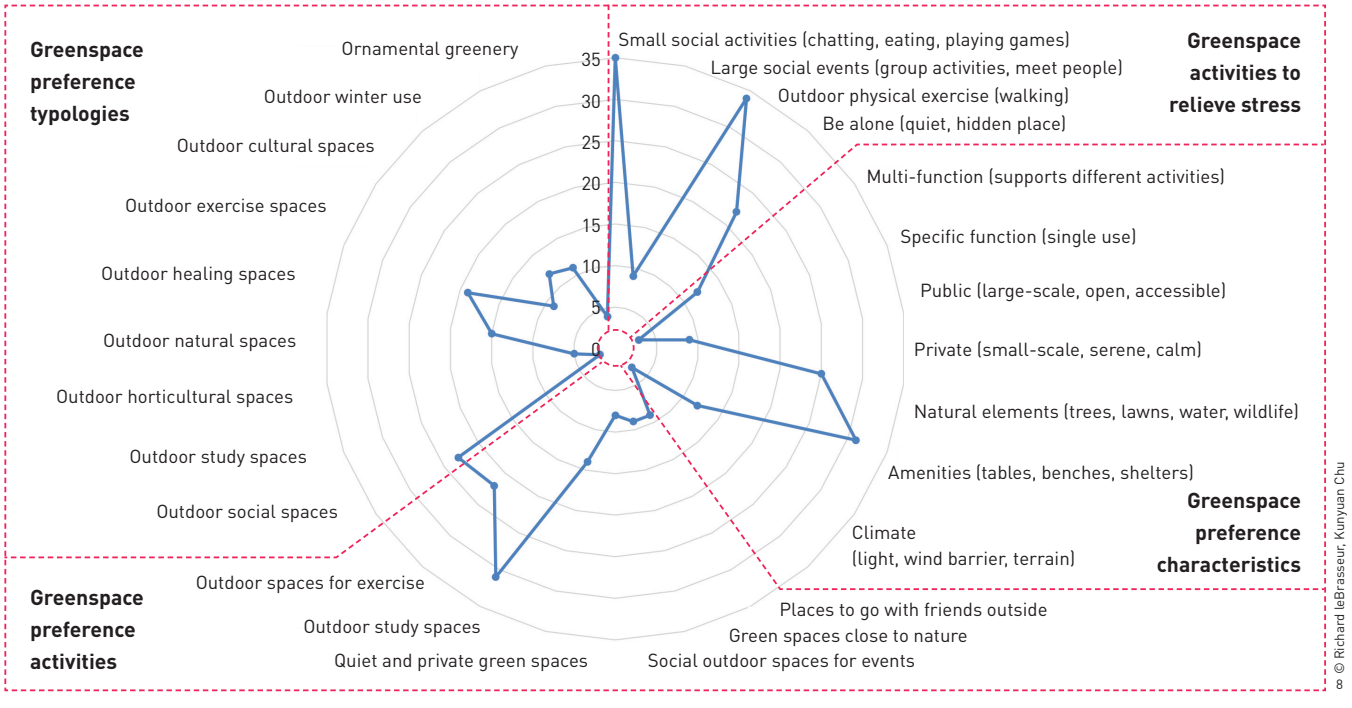
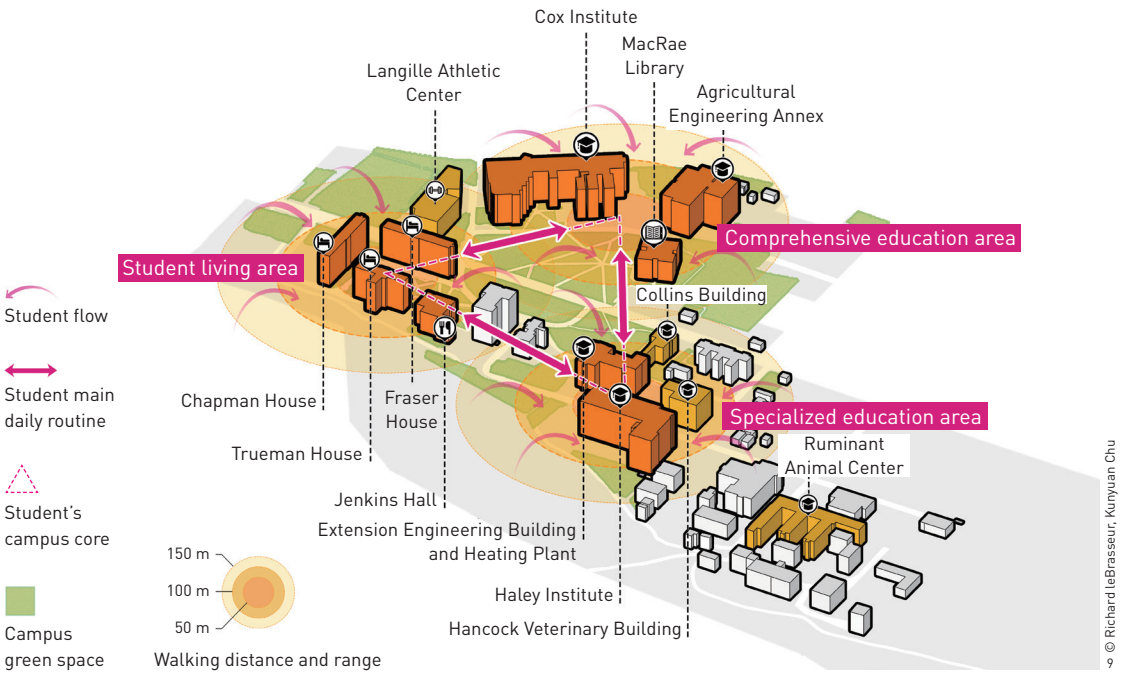


Fig. 8 Students' mean preference strength.



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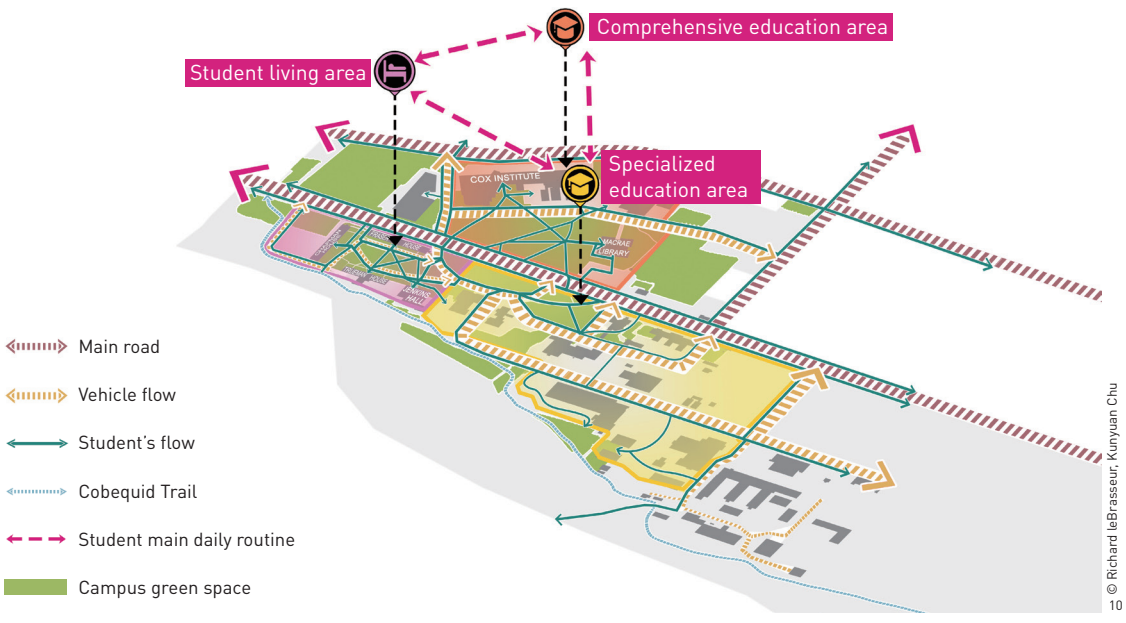

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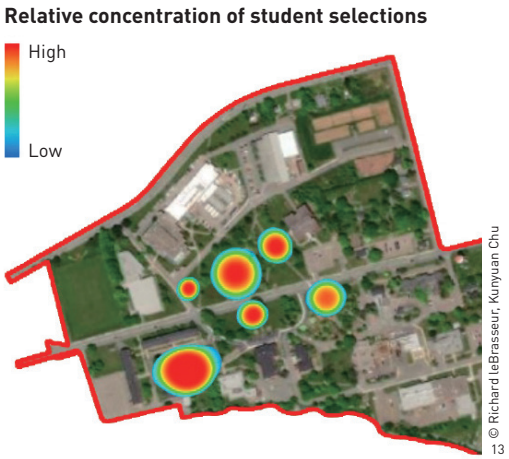
Fig. 9 Core academic clusters around the central campus green space.
Fig. 10 Campus circulation.
Fig. 11 Overview of campus green space characteristics with student living area at bottom right, comprehensive educational area at left, and specialized education area at the top.
Fig. 12 Existing green space at student living area.

and assessment of existing green spaces[89–90]. However, existing literature provides a set of green space physical or structural characteristics and attributes that may affect human well-being (Table 1)[51,81,91–112]. The following five spatial characteristics were correlated with the campus's existing green spaces: 1) size, including area and density; 2) shape, including complexity, diversity, and coherence; 3) proximity, including accessibility, edge conditions, isolation, and connectivity; 4) level of greenness, including vegetation structure, setting, and vegetation density; and 5) maintenance and management, including cleanliness, features and facilities, and safety. When integrated with the prior analysis maps, this table provides a simple procedure to quantitatively and qualitatively assess the therapeutic potential of existing green spaces for students.

This survey's green space preference results (Questions 4–10) were coded to the green space characteristics in Table 1 to generate spatial design locations, qualities, and the specific green space characteristics most preferred by students for emotional and social stress regulation. Results of the student survey and spatial analysis were synthesized within landscape architecture and design to



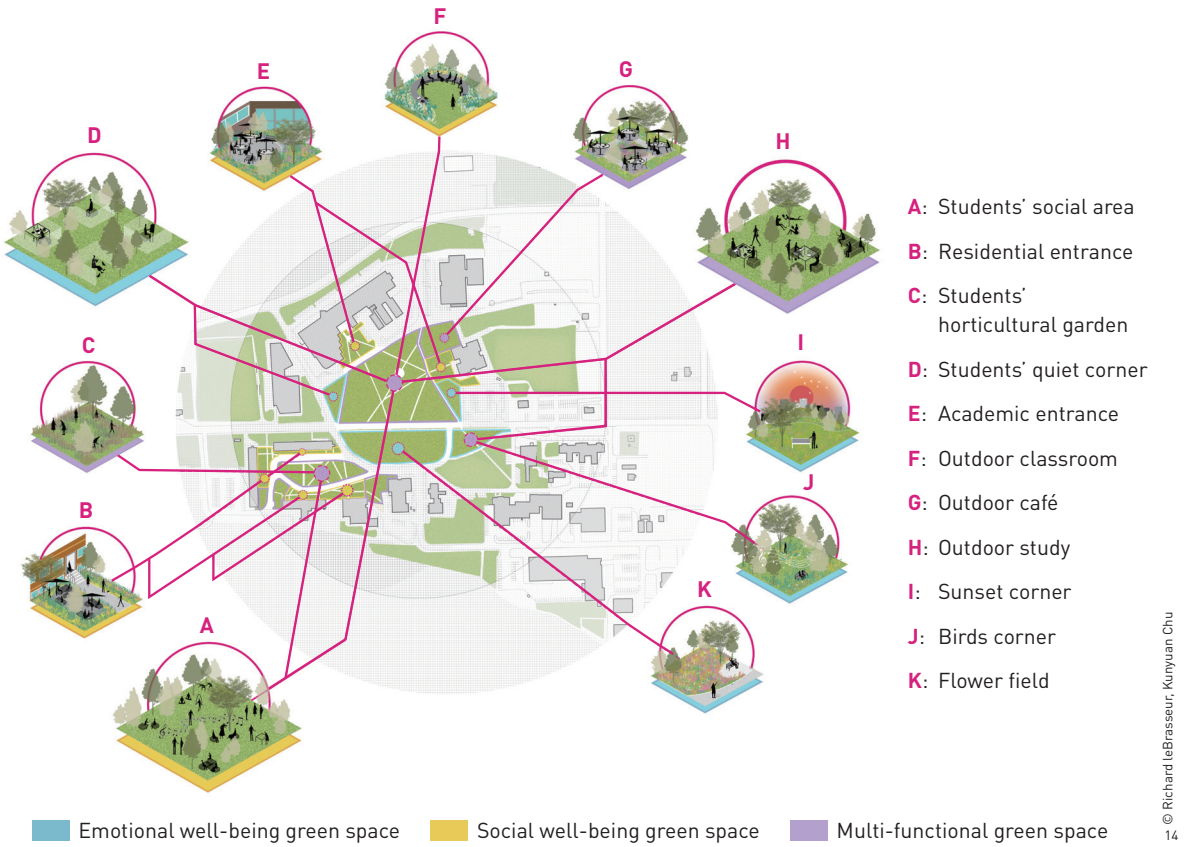


Fig. 13 Heat map of students' preferred locations for restorative green spaces within the core campus. Larger hotspots indicate a greater relative number of student selections.

Fig. 14 Campus stress restoration green space locations with illustrative design features and green space characteristics.

Table 1: Campus green space characteristics, theoretical concepts, and student socio-emotional well-being benefits

Campus green space characteristic	Campus green space description	Student socio-emotional well-being benefits	Source
Size	This characteristic includes green space area and density, which is expressed in Questions 4, 5, 7, 8, and 9 in the survey	· Smaller green spaces provide spaces for "rest" and "socializing" · Larger green spaces buffer urban environments, facilitating health and psychological benefits · Green space percentage positively associates with sense of human well-being; increased depression and anxiety reported for those living in areas with low green space coverage	Refs. [91–93]
Shape	This characteristic includes green space complexity, diversity, and coherence, which is expressed in Questions 4, 5, 6, 7, 8 and 9 in the survey	· A lack of landscape coherence (i.e. visual disturbance), reflects a higher levels of physical disturbance, influences human well-being through stress and reduced mental restoration capacity · Formal green spaces shapes promotes physical or social activity, such as facilities, well-maintained paths, and safety features · Natural characteristics increase stress reduction · Diversity characteristics increase cognitive and social well-being	Refs. [94–98]
Proximity	This characteristic includes green space accessibility, edge conditions, isolation, and connectivity, which is expressed in Questions 4, 5, 6, 7, 8, and 9 in the survey	· Connection to and proximity of green spaces provide safe access and use · Green space edge characteristics impact visibility and the degree of visual penetration of vegetation and depth of view · Accessibility or physical distance to a green space facilitates interaction and use · Access to green spaces increases physical health, social cohesion, and mental well-being	Refs. [51,99–104]

(Continued)

Table 1: Campus green space characteristics, theoretical concepts, and student socio-emotional well-being benefits (Continued)

Campus green space characteristic	Campus green space description	Student socio-emotional well-being benefits	Source
Level of greenness	This characteristic includes green space vegetation structure, setting, vegetation density, which is expressed in Questions 4, 5, 6, 7, 8, 9, and 10 in the survey	· Interaction with more "natural" environments reduces stress levels · Man-made features increase feelings of community and provides accessibility · Social integration increases with a high level of greenness and diversity in vegetation · Vegetation density and edge conditions reduce traffic noise and pollution	Refs. [105–108]
Maintenance and management	This characteristic includes green space cleanliness, features and facilities, and safety, which is expressed in Questions 4, 5, 6, 7, 8, and 10 in the survey	· Management and maintenance qualities directly and indirectly impact well-being through sense of safety and psychological well-being · Green spaces with cultural facilities and amenities increase levels of happiness · Casual interaction improve perceptions of inclusion and a sense of community · Both real and perceived safety affects the use of green spaces contributing to nurturing and restorative environments	Refs. [81,109–112]

produce conceptual plans and diagrams in Figs. 13–15. This graphic-based output is typical in spatial design disciplines and is an effective form of data communication[113]. Figure 13 provides a "heat map" of the student survey results, visualizing the spatial intensity of preferred green space locations. Figure 14 associates student survey responses on preferred and suitable locations with well-being characteristics (Table 1) to illustrate specific green space locations, design features, and spatial attributes. These potential student green spaces are color coded: yellow indicates a primarily social well-being green space, blue indicates a primarily emotional well-being green space, and purple indicates design features and green space characteristics for both social and emotional well-being. Table 2 summarizes these findings.

Lastly, Fig. 15 illustrates a series of small socio-emotional restorative green spaces with specific green space characteristics that meet socio-emotional well-being benefits. These graphics identify and locate students' survey responses to the most appropriate and preferred locations for an outdoor café, a student quiet corner, outdoor study areas, experiential natural spaces for sunsets, birds, and wildflowers, residential and academic entry improvements, and other distinct student-focused social areas.

These graphics link survey-supported well-being green spaces to specific physical locations on campus. The illustrative plans consider the existing green space characteristics in Table 1 and the existing campus spatial context to identify and synthesize the types and features required for student socio-emotional well-being. For example, as shown in the student survey results, the campus restorative green space characteristics most often selected by students included natural elements (63%), small, quiet, and private spaces (44%), and multifunctional spaces with moveable tables, chairs, and overhead shelter (26%). Figure 14 illustrates these preferences with literature-supported green space qualities and attributes from Table 1 to visualize future green spaces.

Fig. 15 Campus green space socio-emotional well-being design characteristics.

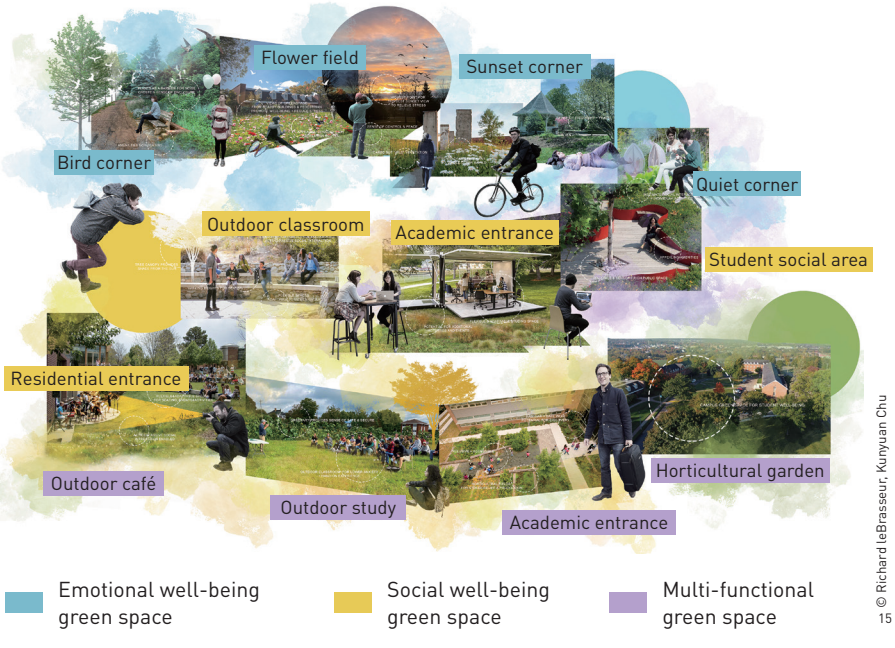


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Table 2: Student well-being benefit, preferred campus green space typology, and restorative characteristics and attributes

Well-being benefit	Preferred campus green space typology	Survey-based green space characteristics	Theory-based restorative characteristics
Social well-being	Outdoor classroom	· Physically connected to other spaces, feels public, with open views to other areas · Natural plants, wildlife, quiet with few benches, tables, and amenities	Dense vegetation, formal, accessible, connected facilities and amenities
	Student social area	· Physically connected to other spaces, feels public, with open views to other areas · Natural plants, wildlife, quiet with few benches, tables, and amenities · Paved, constructed, active, lively with many benches, tables, and amenities · Small social activities, such as chatting, eating, and playing games	Coherent, formal, accessible, connected, facilities and amenities, safe
	Residential entrance (Campus dormitory entrance)	· Physically connected to other spaces, feels public, with open views to other areas · Natural plants, wildlife, quiet with few benches, tables, and amenities · Small social activities, such as chatting, eating, and playing games with others	Dense vegetation, coherent, diverse, connected, facilities and amenities, safe
	Academic entrance (Campus building entrance)	· Physically connected to other spaces, feels public, with open views to other areas	Diverse, formal, accessible, connected, facilities and amenities, safe
Emotional well-being	Sunset corner	· Small, intimate and not physically or visually connected to other spaces, feels enclosed, with few views to other areas · Natural elements · Peaceful and quiet, sense of privacy	Dense vegetation, small size, accessible, connected, safe
	Birds corner	· Small, intimate and not physically or visually connected to other spaces, feels enclosed, with few views to other areas · Natural elements · Be alone, stay in a hidden and quiet place to do your own things · Peaceful and quiet, sense of privacy	Dense vegetation, small size, dense edges, isolated, safe
	Flower field	· Small, intimate and not physically or visually connected to other spaces, feels enclosed, with few views to other areas · Natural elements · Outdoor physical exercises alone or with others, such as walking, jogging, and yoga · Peaceful and quiet, sense of privacy	Dense vegetation, small size, diverse, connected
	Quiet corner	· Small, intimate and not physically or visually connected to other spaces, feels enclosed, with few views to other areas · Natural elements · Be alone, stay in a hidden and quiet place to do your own things · Outdoor physical exercises alone or with others, such as walking, jogging, yoga · Peaceful and quiet, sense of privacy	Dense vegetation, small size, diverse, accessible, isolated, safe
Both social and emotional well-being	Outdoor café	· Physically connected to other spaces, feels public, with open views to other areas · Natural plants, wildlife, quiet with few benches, tables, and amenities · Paved, constructed, active, lively with many benches, tables, and amenities · Small social activities, such as chatting, eating, and playing games	Dense vegetation, formal, accessible, connected, facilities and amenities, safe
	Outdoor study	· Physically connected to other spaces, feels public, with open views to other areas · Natural plants, wildlife, quiet with few benches, tables, and amenities	Casual interaction, coherent, dense vegetation, dense edges, facilities and amenities, safe

(Continued)

Table 2: Student well-being benefit, preferred campus green space typology, and restorative characteristics and attributes (Continued)

Well-being benefit	Preferred campus green space typology	Survey-based green space characteristics	Theory-based restorative characteristics
Both social and emotional well-being	Horticultural garden	· Small, intimate and not physically or visually connected to other spaces, feels enclosed, with few views to other areas · Outdoor physical exercises alone or with others, such as walking, jogging, and yoga · Natural plants, wildlife, quiet with few benches, tables, and amenities · Peaceful and quiet, sense of privacy	Dense vegetation, small size, dense edges, coherent, formal, diverse, accessible, isolated, connected, safe

NOTE

Green space typologies are derived from survey Questions 6 and 7. Survey-based characteristics are summarized by Questions 4, 5, 8, 9, and 10. Restorative characteristics are illustrated conceptually per the mechanisms of restoring and building capacities outlined in Section 1.2, Fig. 3, and Table 1.

Table 2 supports Figs. 14 and 15 by listing the preferred green space typology and well-being benefit with specific green space characteristics and attributes.

Simply stated, Figs. 14 and 15 synthesize survey results, analysis maps, and literature-supported tables to identify the location, accessibility, and specific socio-emotional well-being green space characteristics that can inform future design intervention opportunities for the campus. Of note, this was not a suitability map, but a general orientation of where students prefer to interact with restorative green spaces through design intervention.

4 Discussion and Prospect

The relationship between stress and academic performance is complex. A synergistic area of high performance occurs with certain levels of stress: moderate stress is considered beneficial to academic performance and can provide positive feelings of accomplishment and fulfillment, whereas distress has negative academic consequences and often results from academic overload. The study's results identify strategic intervention times for the university (i.e. when to promote outdoor green space interaction) and the types of green spaces that can promote specific forms of social or emotional well-being (i.e. where to promote outdoor green space interaction). In doing so, stress overload periods may be reduced to optimal or eustress levels, thereby potentially improving academic performance and overall student well-being. These distressed time periods are largely consistent with a pan-Canadian study by Brooke Linden and colleagues, who reported that December, similar to weeks 11–12 in this study, was the most stressful period[11]. Other studies of university student stress similarly report heightened stress during these periods, supporting the temporal patterns observed in this study [114–116]. Figure 16 illustrates how student green space interaction during weeks 5–7 and weeks 11–12 can improve socio-emotional well-being through prescriptive green space typological interaction with specific green space characteristics and attributes.

Results also clarify the spatial typologies and characteristics important to campus green space stress relief and the maintenance or improvement (i.e. regulation) of socio-emotional well-being. Overall, students stated that they prefer numerous, intimate, enclosed green spaces over public, open, and connected ones (63%). They also preferred quiet, natural green spaces with wildlife and birds over active, constructed, lively green spaces such as plazas and building entries (81%). These results reflect Qunyue Liu et al.[117], who investigated the mental health of university students living on campus and found that campus green spaces had a beneficial impact on psychological well-being. Similarly, after accounting for individual socio-demographic factors, another study found a negative correlation between exposure to campus green spaces and mental health problems among Chinese university students[118]. Related studies support these findings, including Joseph Baur[119], who reported that students who interacted with campus gardens increased their sense of connectedness to nature and overall health, both significant predictors of general well-being. A 2022 study[80] similarly indicated that students consistently prefer campus areas with high levels of greenery, diverse trees and flowers, blue-space views, peacefulness, quietness, pleasant smells and sounds, and benches and tables, all of which can facilitate restorative experiences.

Seventy write-in responses for Question 10 identified specific preferred campus green space typologies, including "indoor area

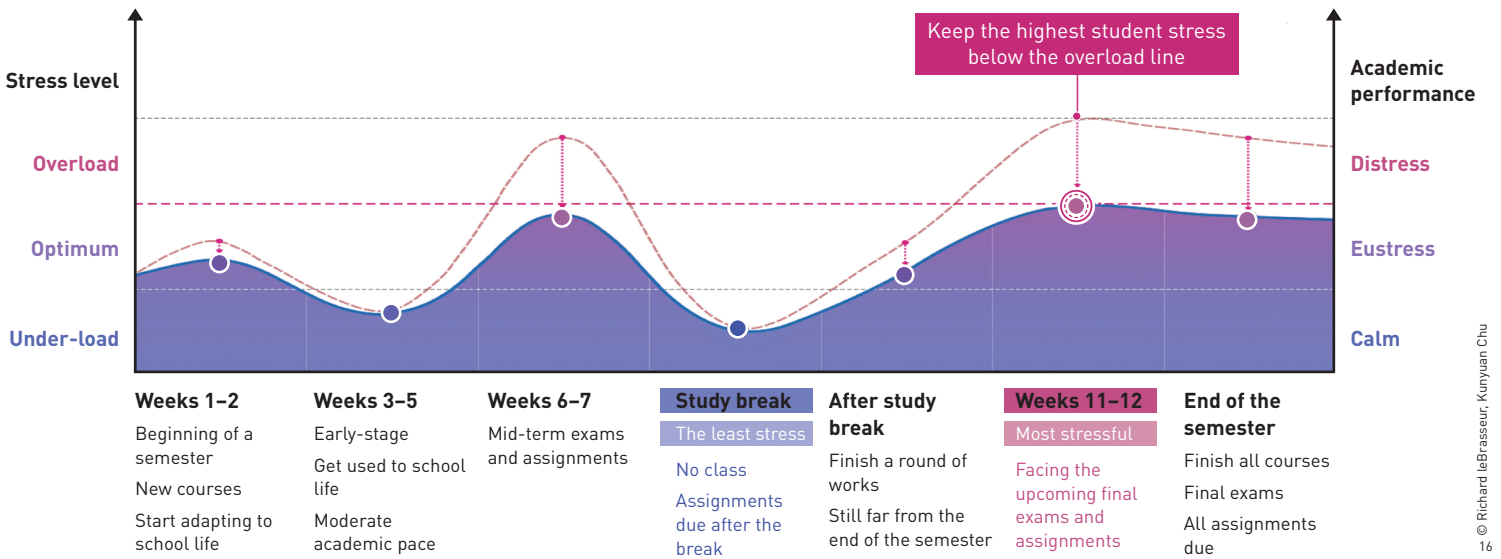

Fig. 16 Conceptual curve of student stress during the semester: adjusted curve through green (solid line) and original curve (dashed line).

with views to greenery" (N = 18, 26% of responses), "outdoor café" (N = 12, 17%), and "indoor garden or greenhouse" (N = 11, 16%). These preferences for indoor green spaces may be attributed to the long winter climate of Nova Scotia, Canada. Interestingly, only three students suggested meditation areas, although *in-situ* nature meditation clearly shows stress-regulation benefits[120], among university students[121–122]. This result may be explained by the climate as well as prospect and refuge theory[123], which suggests that campus environments combining visual openness (prospect) with sheltered or secluded areas (refuge) can promote security, ease anxiety, and enhance comfort and personal control.

Overall, this study's outcomes are supported by Lori Pullman[124], who found that naturalistic campus green spaces positively affect students' psycho-physiological well-being and that well-maintained campus green spaces improve students' sense of belonging. Another study showed that campus landscape biodiversity had significant effects on physiological and psychological recovery in students, with high-biodiversity environments producing better recovery effects than low-biodiversity environments[125]. Additionally, greener campus landscapes correlated more strongly with students' positive sense of belonging than non-green campus spaces[60]. Similarly, centrally located green spaces have been shown to provide opportunities for frequent social interactions, thereby increasing student social cohesion and improving mental health outcomes[126].

Prior research has demonstrated that greenery on university campuses helps students relieve frustration[127], lower stress levels[128], support mental recovery[79], and enhance psychological and physical health, which are components of overall well-being and quality of life[75]. However, much of this research centers on general exposure to nature, such as viewing nature within the campus or making brief visits, rather than investigating how university students engage with various campus spaces and their qualities in daily routines. This study extends that work by examining the relationship between students' actual preferences and behaviors within specific campus green space typologies and their spatial characteristics and features, offering a more focused perspective on how campus environments influence student socio-emotional well-being.

The campus green spaces conceptually illustrated here allow students to develop a sense of identity, thereby enhancing self-esteem and self-resilience and minimizing the probability of social stress. Social contact promotes students' interaction within the campus and academic community and helps create a sense of "belonging"[129]. Centrally located green spaces can provide opportunities for frequent social interactions, thereby increasing campus/community cohesion, improving campus safety, and enhancing socio-emotional well-being outcomes[127,130]. Well-designed campus green spaces encourage engagement in planned and spontaneous social activities in a natural setting, enabling individual and shared growth and constructive interpersonal relationships.

Collectively, these findings add to the current body of research on restorative and therapeutic landscapes and student behavior on university campuses. This study highlights key considerations for future campus design and planning that can improve the capacity to regulate and relieve students' socio-emotional stress.

The results can inform future design and green space

management strategies for campus landscapes that support overall student well-being, reduce stress in the university setting, and improve academic performance. Such green spaces could augment university counselling and support services with strategies that enhance students' emotion management and ability to cope with conflict situations. Prescribing campus green space interaction and supporting outdoor activities can serve as pathways to nature-based solutions for student health concerns. For example, Elizabeth W Holt and colleagues[58] found that students who regularly interacted with green spaces in active ways reported enhanced quality of life, improved overall mood, and reduced perceived stress. However, interactions with passive green spaces showed no strong correlation with health and well-being indicators.

Stress is a holistic experience for many university students and has varied contextual determinants. The results of this study should be interpreted in light of several limitations. The survey's development and delivery had limits and raise validity concerns because of the sample size and the study site's limited representativeness of more typical large urban university campuses, making the findings less generalizable. Although the stress-related response options were explicitly defined to reduce ambiguity, the survey did not include options for students who did not experience or acknowledge stress; thus, context effects[131] may have unintentionally influenced respondents' answers. For instance, the survey response choices did not allow for neutral positions or "non-stressed" answers. There was no pre-screening or self-report for current mental-health or stress states (i.e. subjective well-being, baseline mental health, or stress status). Similarly, no data were collected for socio-economics, race, disciplinary major, overall health, or other factors that may have served as response moderators.

Furthermore, the socio-demographic data were not applied in the simple statistical analysis due to anonymity; thus, their moderating effects on stress and stress-relief preferences were not revealed. Studies report that different groups of people have varying degrees of vulnerability and sensitivity to stressors and their responses to them[132–133]. However, there is a lack of studies on the possible role of gender, ethnicity, and/or immigration status in moderating the relationship between socio-emotional well-being and stress. Other moderators not assessed in this study include students' academic self-efficacy, or their belief in their capability to perform academically[134]; when students perceive academic requirements as stressful, their academic self-efficacy may decrease[135].

Both student subjectivity, including current socio-emotional state, and differences in campus green space characteristics make it difficult to develop all-encompassing design recommendations[136]. In light of these limitations, no specific data relationships or cross-sectional statistical analyses were completed; however, the simple structure of the data results is considered reliable for this research. No quantitative measures or levels of the green space characteristics and attributes in Table 1 were completed for this study because the research objectives did not require such measurements. The literature noted in Table 1 does provide spatial design-relevant descriptions of those characteristics on which to begin basing this study's conceptual design outcomes, as shown in the illustrative figures.

Future research on this topic should be multi-center and include student data from several educational institutions. Additionally, multilevel analysis could consider specific needs and demands by geographical location or sociodemographic characteristic. It will also be important to test possible moderators such as academic discipline, existing stress levels, socio-emotional well-being states, and other student-based factors. A longitudinal study should evaluate changes in the variables investigated here as students progress or use pre- and post-green space intervention measures. Lastly, other mediation and moderating pathways, both direct and indirect, between campus green space qualities and characteristics and student stress outcomes should be measured. This includes spatio-temporal factors within students' calendars, such as changing seasons and weather.

5 Conclusions

Campus green spaces build student socio-emotional capacities and skills while facilitating greater involvement with the campus and the perception of outdoor spaces as part of the academic and student landscape. This research provides a set of therapeutic campus green space characteristics and spatial concepts that serve as interactional mechanisms to relieve student stress, reduce anxiety, and increase well-being for the study population.

This research supports interdisciplinary relationships so that this knowledge may be considered in the spatial planning, design, and management of campus landscapes. This study communicates evidence-based design and adds beneficial information to the existing knowledge base on green space design and theory for this user group. It contributes to the identification of specific green space characteristics, attributes, and spatial configurations within campus outdoor spaces that positively influence students' socio-emotional well-being and stress reduction. This information is

important for developing strategic landscape design improvements and management changes in higher education; campus green space design should increase the possibility of active student use. These green space characteristics can be adapted, supplemented, and applied in many campus locations and contexts.

Campus green space interventions can supplement current university well-being programs and initiatives, such as mental-health and other student wellness resources. Mitigating stress and improving university students' emotional and psychosocial well-being are key to their transition into future careers and their interpersonal capacity to manage life situations.

ELECTRONIC SUPPLEMENTARY MATERIAL

Supplementary material is available in the online version of this article at https://doi.org/10.15302/J-LAF-2026-0034.

Competing interests | The authors declare that they have no competing interests.

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支持大学生社会情感福祉的校园绿地概念框架

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摘要

许多大学生因生活转型期的多重要求而承受压力与焦虑，其心理健康亦受到影响。校园绿地可作为基于自然的干预手段，缓解学生压力并改善其社会情感福祉。本研究识别了校园绿地的具体特征，并将其视为基于自然的疗愈机制，以促进学生压力缓解与校园绿地互动之间的积极空间关联。通过问卷调查，评估学生对压力、压力高发时段、减压行为，以及可能缓解压力感受的校园绿地条件、类型和潜在互动方式的认知与偏好。结果显示，大学生最偏好为社交活动和体育锻炼设计的小尺度户外空间，对大型社交空间的偏好相对较低。学生偏好的绿地特征包括自然风格、小尺度、宁静安谧且具有私密性的空间，而对单一功能空间的偏好最低。这些结果揭示了大学生当前及理想状态下与减压型校园绿地之间的关系，并可为优化空间配置提供依据。本研究通过案例空间分析与概念性图示，以循证设计方式呈现研究结果。大学生的情绪福祉与心理社会福祉，是其顺利迈向未来职业生涯以及提升应对生活情境的人际能力的关键。通过策略性设计与管理校园绿地，可在学期期间调节学生的压力水平，并促进其学业成功。

关键词

大学生压力源；社会情感福祉；校园绿地；景观偏好；循证设计研究

文章亮点

- 发现学生更偏好自然、安静、小尺度且具有围合感的绿地空间以缓解压力
- 识别有助于提升学生福祉与缓解压力的绿地特征
- 提出通过空间互动缓解学生压力的设计策略