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Effects of Mixed-Use Green Roof on Student Community & Subjective Well-Being

A Case Study of the University of British Columbia's Exchange Residence
Green Roof

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Effects of Mixed-Use Green Roof on Student Community & Subjective Well-Being: A Case Study of the University of British Columbia's Exchange Residence Green Roof

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EXECUTIVE SUMMARY

A growing body of research indicates that university green spaces positively impact the subjective well-being of university students by providing benefits to physical and mental health and good social relations. The green roof of the University of British Columbia's Exchange Residence building shares many features of conventional green spaces, but its location over an active bus exchange and integration into a high-density residence building may impact its well-being potential. This small-scale, exploratory study investigates how the green roof's unconventional design elements affect users' perception of the space and its effect on their subjective well-being. Using qualitative methods, a total of eight participants (including student residents of the building, non-resident students, and Building Operations staff) were interviewed. The results show that some green roof users perceive the space as providing restorative and social benefits including emotional relief from stress and improved social cohesion. Although these users perceive the space as being less natural and restorative than other campus green spaces, its convenient location is a significant factor in participants' preference for visiting the green roof over more natural spaces. The study results also suggest a social-restorative benefit trade-off between green spaces that are perceived as highly natural and green spaces that have greater visibility. The paper concludes with recommendations for improving the green roof's well-being benefits and suggestions for future research.

I. INTRODUCTION

Campus green spaces, ranging from manicured flower beds to grassy fields and wooded groves, are associated with the improved subjective well-being (SWB) of university students (Hipp et al., 2016; Holt et al., 2019). SWB is a multidimensional measurement of how a person thinks or feels about their life that usually incorporates four components: physical and mental health, security, freedom of choice and action, and good social relations (Reyes-Riveros et al., 2021). Stress, anxiety, depression, and social isolation can impact the SWB of many university students, necessitating opportunities for social and environmental interactions that mitigate these impacts (Holt et al., 2019; Kovich & Simpson, 2019). A growing body of research over the past decade has demonstrated that experience in green spaces (vegetated areas with grass, trees, and shrubs) positively affects the “physical and mental health” and “good social relations” dimensions of SWB by: reducing stress and creating feelings of restoration (Bell et al., 2018; Carrus et al., 2013; Liu et al., 2018; Reyes-Riveros et al., 2021); inducing social interactions and facilitating social cohesion (feelings of interpersonal connectedness, trust, and belonging; Holt et al., 2019; Jennings & Bamkole, 2019); and encouraging emotional attachment to place (Maas et al., 2009). The well-being potential of campus green spaces has thus led to a growing interest in campus initiatives that aim to provide students with frequent and convenient access to green space (Hipp et al., 2016; Holt et al., 2019).

The University of British Columbia’s (UBC) Exchange Residence building addresses this aim through a green space that has been incorporated into a multipurpose structure: a podium that serves as both the roof of a TransLink bus exchange and a functional area for resident recreation. This structure (hereafter referred to as the green roof) aims to contribute to several goals outlined in the UBC Green Building Action Plan (GBAP), including enhanced student well-being and improved campus sustainability amidst increasing student density (DIALOG,

2021; University of British Columbia, 2018). The green roof incorporates many green space features, such as planted borders and containers, an artificial turf field, a paved walkway, and areas for recreation and seating (see **Appendix A**). However, its non-traditional design elements (including its location over a bus exchange and incorporation into the structure of a residence building) may affect its function as a green space and its potential contributions to student well-being, particularly in comparison to other available green spaces on the UBC campus. With student population density projected to continue increasing at UBC amidst fixed spatial constraints (DIALOG, 2021), trends of incorporating green spaces into high-density infrastructure may continue. We therefore sought to understand how the mixed-use design and other elements of the green roof (including its soundscape, planting, and visual aesthetic) affect users' perception of the space, their interactions with and within it, and its well-being potential by conducting a small-scale, qualitative inquiry into the following research questions:

1. How is the green roof used and experienced by UBC students?
2. How do UBC students perceive the green roof's effects on their subjective well-being?

II. METHODS & ANALYSIS

The approach applied in this study is theoretically constructivist, anchored in the paradigm that the experienced effects of a space are created through personal perceptions and social interactions. Focusing on the inherently subjective viewpoints of eight research participants, this study used qualitative methods to explore how the green roof and its social and emotional effects are perceived and understood by its users. The phenomenological approach and open-ended design employed in this study centres research participants' perceptions of the green roof to generate insights into the space's benefits and limitations (Marshall & Rossman, 2016; Reyes-Riveros et al., 2021). As Bourke (2014) states, scholars engaged in social science research should not interpret participants' lived experiences based on their own positionality and

experience. With this in mind, none of the researchers have lived in a student residence with access to a green roof and, prior to the study's commencement, had not visited the green roof in the Exchange Residence building. To account for biases, the researchers analyzed each data set separately then worked collaboratively to cross-check our analyses and ensure that the study was not inordinately influenced by any one researchers' perspective.

Our literature review determined that the well-being potential of a green space is mediated by various characteristics, including: perceived naturalness (the level of man-made elements; Carrus et al., 2013; Liu et al., 2018); perceived amount and type of biodiversity and wildlife encounters (Bell et al., 2018; Reyes-Riveros et al., 2021); how the space is used (Holt et al., 2019); its noise level and soundscape (Liu et al., 2018); and its ability to foster a sense of privacy and security (Chen & Yu, 2011). Using these characteristics as reference points, we conducted three hours of observation on the green roof; these observations were coded and used to inform interview questions. Following the observations, a total of eight individual, semi-structured interviews were conducted with three categories of participants: one Building Operations staff member, two student residents, and five non-resident students. The combination of resident and non-resident student participants was necessitated by the project timeline, which required interviewing to begin before ethics board approval was received for recruiting residents of the building. Recruitment took place via email invitation and by approaching green roof users as they visited the space. Interviews were conducted both online over Zoom video calls and in-person on the green roof (following COVID-19 safety protocols). Three interview formats were employed: semi-structured online interviews, semi-structured online interviews with photo elicitation (using the images provided in **Appendix A**) and in-person ambulatory transect interviews on the green roof (Table 1).

Table 1: Participant information, interview format, interview language, and duration.

Participant	Categories	Interview Format	Language
A	Building Operations Staff	Online semi-structured	English
B	Non-Resident Student	Ambulatory	English
C	Non-Resident Student	Ambulatory	English
D	Non-Resident Student	Ambulatory	Chinese Mandarin
E	Non-Resident Student	Online with photo elicitation	Chinese Mandarin
F	Non-Resident Student	Online with photo elicitation	English
G	Student Resident	Ambulatory	English
H	Student Resident	Ambulatory	English

The interview with the Building Operations staff member focused on their professional observations of green roof use and ease of maintenance, while interviews with student residents and non-resident students focused on the perceived benefits and drawbacks of the green roof, its effects on SWB, and perceptions of campus green spaces more broadly. The interview questions were designed according to the five green-space characteristics related to well-being identified in our literature review (see **Appendix B**). The interviews were audio-recorded and transcribed for qualitative analysis and manually coded by both researchers. Two interviews with non-resident students were conducted in Chinese Mandarin and then translated into English by one of the researchers, who is fluent in both languages. To ensure the accuracy of data collected, each participant reviewed their interview transcript with the opportunity to add, amend, or remove any information. Our analysis involved a combination of mixed deductive and inductive coding processes: deductive coding analyzed data according to predetermined themes (e.g., naturalness), and inductive coding identified emergent themes that were not predefined but were relevant to our research interest (e.g., convenience). Each researcher coded and analyzed the interview transcripts individually, then compared results through peer debriefing and theme matching processes.

IV. FINDINGS & DISCUSSION

Participants perceived the green roof to have an aggregate positive effect on two key dimensions of SWB: emotional and mental health and good social relations. Our analysis linked two overarching functions of the green roof to this positive well-being effect: first, it allows residents to have convenient access to an outdoor space, which provides feelings of restoration, escape from stress, and connection to nature; and second, it encourages social cohesion by providing a space that facilitates social connections and increasing emotional attachment to place. Non-resident participants highlighted this latter function, describing the space as particularly suited to social activities and community building while also describing it as less natural and restorative than other green spaces on campus. Resident participants affirmed these findings, yet also emphasized the significance of the green roof's convenience (i.e., its proximity to the residence building) in comparison to other campus green spaces. Each well-being function is discussed further in this section, while also attending to factors that mediate the green roof's well-being effects and comparisons with other campus green spaces.

Restorative benefits of the green roof and the role of convenience

The green roof provides its users with an accessible outdoor space where they can experience the restorative benefits of its natural features including fresh air, open sky, a quiet soundscape, and (on sunny days) a space to enjoy sunlight. Resident participants reported experiencing an emotional difference before and after visiting the green roof, including reduced levels of stress, an increased sense of calm, and increased energy. One resident, Participant G, described using the green roof for study breaks, stating that the shift from an indoor to an outdoor environment provided a sense of escape from the pressures of school and made them feel "refreshed" after their visit. Another resident, Participant H, described the green roof as providing a similar sense of emotional uplift and escape from life's day-to-day stresses:

Participant H: "If I'm in my room, cooped up, I'll just be thinking about studying, cooking, it's robotic. But then once I'm out, it feels more free. You get an uplifted mood, you get happier maybe. You get a boost, more energetic. So it helps."

These results align with findings from previous studies that highlight the restorative benefits of outdoor spaces, with green spaces serving as a buffer for emotional stress and creating restorative benefits that improve users' attention and focus (Holt et al., 2019; Liu et al., 2018). By providing a space where residents can easily access these emotional and restorative benefits, the green roof appears to positively impact the SWB dimension of mental and emotional health.

While the green roof's natural elements and features as an outdoor space seem to provide its users with restorative benefits, both resident and non-resident participants perceived the green roof as having an overall low level of naturalness. This low level of naturalness was particularly highlighted by participants who had visited other green spaces on UBC campus (such as the Rose Garden or the Nitobe Memorial Garden) and at other universities. According to our participants, elements of the green roof that negatively impact its perceived naturalness include: the prevalence of materials such as gravel, concrete, and artificial turf; the type of vegetation, which is dominated by grasses and low-lying shrubs that are often red or brown in colour; the diversity of vegetation (i.e., planting dominated by relatively few species); and the roof's overall colour palette and aesthetic, described by participants as "modern," "surreal," and "like a cartoon." Participants described other campus green spaces as using more natural materials, appearing "greener," having a greater diversity of vegetation, and a more "natural" or "wild" aesthetic. Some participants also stated that other campus green spaces create a greater sense of "protection" (i.e., like being in a "bubble"). This contrasts with the "openness" of the green roof, which is characterized by low-lying vegetation constrained to the planted border and is highly visible to all residents on the west- and south-facing sides of the residence building. (For an

illustration of the contrasting vocabulary used by participants to compare the green roof to other campus green spaces, see **Appendix C.**)

Participants described the artificial turf as having a particularly negative impact on the perceived naturalness of the space. Multiple participants framed this impact as multisensory: they described the artificial turf as differing from a living lawn in its visual, tactile, and olfactory effects. One participant discussed their preference for the feel and smell of living grass, while another stated that the experience of walking on real grass evokes different sense memories than artificial turf. However, many participants also acknowledged the benefits of artificial turf in terms of its lower maintenance requirements. The Building Operations staff participant confirmed this view, stating that artificial turf contributes to the green roof's overall low level of maintenance:

Participant A: I love the green turf. It's very nice. It's the same all-year round. Real grass gets messed up easily during the summer time, but turf looks the same all-year round.

The negative impact of the artificial turf on the green roof's perceived naturalness may therefore be justified by its lower maintenance costs. However, participants' attention to the multisensory nature of "real grass" suggests that perceived naturalness and a sense of connection to nature is associated with multisensory stimulation (i.e. vegetation that is not only aesthetically appealing but also has tactile and olfactory interest). Avenues for mitigating the artificial turf's impact on perceived naturalness may therefore include increasing the diversity of planting in other areas of the roof by incorporating plant species that create multisensory interest, and expanding planted areas throughout the roof (through the use of containers) rather than relegating it to the green roof's border.

While other campus green spaces were described as being more natural, participants did not link greater naturalness to greater frequency of use. Despite being described as more natural

and restorative overall, participants also stated that UBC campus green spaces such as the Rose Garden and the Nitobe Memorial Garden are less convenient and therefore receive less use. For example, a non-resident participant spoke positively of the Rose Garden's restorative benefits, but also noted that they rarely spend time there due to their busy schedule:

Participant C (when asked if they visit other green spaces frequently): "I haven't been in a while. Sometimes I walk up to the Rose Garden, but just to the lookout point. I kind of look down at the garden because I'm usually just going in between classes and I have my job as well."

This statement illustrates that, with their time consumed by school and work schedules, students may feel that they have to go out of their way to visit (and thus receive restorative benefits from) green spaces on campus. This contrasts with the convenience of the green roof, which is built into the structure of the Exchange Residence building and can be visited by residents without a significant time commitment. This greater ease of access is illustrated in one resident participant's anecdote about the green roof:

Participant H: "One day, me and my friend were like, 'Oh it's sunny outside!' so we just went out and did photo shoots. Just stared at the sun. It was a good, relaxing experience. We're in engineering, so it's super stressful."

This spur-of-the-moment visit to the green roof provided this participant with restorative benefits without requiring that they allocate significant time to the visit. The green roof's convenience thus lowers potential barriers to access such as lack of time.

Social benefits of the green roof and social-restorative trade-offs

Every participant described the green roof as a social environment that facilitates social interactions, indicating the green roof's positive impact on the SWB measurement of good social relations. Examples provided by participants of social activities that the green roof facilitates include: social gatherings with friends and acquaintances; playing sports (e.g., "Spikeball," "volleyball," "badminton"); and consuming food and drink (e.g., "coffee dates," "having a picnic"). Some participants also highlighted the green roof as a space for making new social

connections. One resident described their observation that distinct social groups “mingle around” on the green roof. Another highlighted the importance of having outdoor spaces near to student residence buildings because they create a good environment for “bonding experiences.” These observations made by participants demonstrate that the green roof may both support existing social connections and facilitate community building by providing a space where users can create new social connections.

This latter quality contrasts with other campus green spaces, which were not associated by participants with the creation of new social connections. Instead, more natural and private green spaces (such as the Nitobe Memorial Garden, which has tall and thick vegetation that one participant described as being “like a maze”) were associated with solitary visits or spaces to spend time with close friends:

Participant F: “Whenever you go to green spaces like that, you bring friends that you feel comfortable with. So I would never go to a green space with... I mean, I would go with a stranger, but it’s more like a place I would go to socialize with people I really feel comfortable with.”

This contrast suggests that there may be an indirect trade-off between green spaces with a high level of naturalness and those that facilitate community building. While a green space’s ability to foster a sense of privacy and protection is associated with greater restorative benefits (Chen & Yu, 2011), it may discourage users from making new social connections. Lower levels of visibility and the expectation of privacy may be linked to safety concerns about visiting with or approaching people with whom the green space user is less comfortable. The green roof, in contrast, is an open space with high levels of visibility. It is therefore possible that in sacrificing a degree of naturalness and privacy (factors associated with restorative benefits; Carrus et al., 2013; Liu et al., 2018), the green roof becomes more suited to facilitating new social connections between users.

Overall, residents of the building spoke very positively of the green roof, suggesting that it encourages an emotional attachment to their place of residence. One resident described the green roof as making the building feel more “homey.” Emotional attachment to place can have significant SWB benefits. A study by Maas et al. (2009) found that even when green spaces do not facilitate a greater number of social contacts, they can still promote a sense of community. People with green spaces in their environment feel less lonely and experience less shortage of social support due to increased place attachment. This result is reflected in our findings, in which participants’ positive associations with the green roof suggest that their time on the green roof (even time spent alone rather than building social connections) may encourage them to feel more positively about the Exchange Residence community as a whole.

V. RECOMMENDATIONS

Despite the possibility that a lower degree of naturalness and privacy allows the green roof to better foster social cohesion, most participants expressed preferences for a greater degree of naturalness. Because the restorative benefits of green space are correlated with perceived naturalness (Carrus et al., 2013; Liu et al., 2018), the well-being potential of the green roof may therefore be improved by increasing the space’s perceived naturalness and encouraging the user’s sense of connection to nature. This may be achieved by diversifying the type of vegetation and location of planting to create heterogeneous habitats that foster greater biodiversity for plants and animals. The green roof’s planted areas are currently concentrated along the borders, creating a sense of segmentation and artificiality. We recommend creating a continuous transect of natural elements (such as plants) throughout the green roof by adding portable planters and pots. One participant suggested creating a community garden that would encourage user engagement with the space and

direct human-plant interactions. Elements of the green roof that reduce its perceived naturalness such as gravel, concrete, artificial turf and colour palette should be minimized.

Furthermore, users' experience on the green roof may be improved by increasing its overall user-friendliness. User engagement may be promoted by adding informational signage that describes natural elements (e.g., plant characteristics and habitats) and amenities such as the gravel boules court (which created confusion for many participants). Multiple participants also expressed their hesitation to visit the green roof on rainy days due to the lack of covered areas, which results in unusable amenities (e.g., wet seating) and greatly reduced use during winter months. The addition of protective canopies may encourage year-round use. Some participants also noted the lack of available (or easily visible) waste receptacles on the green roof. Adding easily accessible receptacles, such as UBC Sustainability Sort It Out stations, may help maintain the green roof's cleanliness and increase overall user-friendliness. (For a list of design recommendations, see **Appendix D.**)

VI. CONCLUSION

This paper has demonstrated the aggregate positive effect on SWB created by the UBC Exchange Residence building's green roof as perceived by the study participants. By providing convenient access to an outdoor space that offers restorative benefits, fosters a sense of connection to nature and emotional attachment to place, and facilitates social cohesion, the green roof appears to contribute to the improved mental health and social connectedness of student residents. While we have suggested potential avenues for improving users' experience of the green roof and increasing these positive well-being effects, decision-makers should be aware of potential trade-offs between restorative benefits (created by increasing a space's perceived naturalness) and social benefits, as well as overall user-friendliness and convenience. It is also possible that indoor spaces may function to increase social cohesion in the same way as the green

roof. Future researchers may therefore consider a large-scale survey of the student population to explore which type of social space (indoor or outdoor) students prefer and to determine the prevalence of various preferences for degrees of perceived naturalness. In doing so, researchers may further inform future avenues for aligning the university's goals for sustainable development with the improved SWB of its students.

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APPENDIX

Appendix A: Photos of the green roof captured on Nov 10, 2021.

Image 1



Image 7



Image 2



Image 8



Image 3



Image 9



Image 4



Image 10



Image 5



Image 11



Image 6



Image 12



Appendix B: Example of Interview questions designed according to the characteristics of green roof related to well-being.

Characteristics	Question
Perceived naturalness	Would you describe this space as being more natural or unnatural? Why?
Perceived amount and type of biodiversity and wildlife encounters	Which aspects of this space would you describe as seeming natural or that remind you of nature? What are the differences of the vegetation in the green roof compared to those green spaces that you visited before?
How the space is used	What sort of activities do you think this space would be good for? When you are at the green roof, what sort of activities do you see other people doing? Can you tell me about a specific experience you had while on the green roof?
Noise level and soundscape	Can you describe what you hear and how does it make you feel?
Ability to foster a sense of privacy and security	How do you feel when you are on the green roof? When you have high vegetation/vegetation above you, is there a specific feeling that that provides? Are there elements of the roof that would make you want to spend time here?

Appendix C: Illustration of words used by participants to describe the green roof versus other campus green spaces.

Green roof:

Pleasant Modern
Cartoon Surreal Artificial
Bright Hotel Yellow
Red Vibrant White
Grey Spacious
Open Gravel

Other campus green spaces:

Protected Diversity
Imperfect Thick Wild Maze
Zen Nature Tall Water
Wildlife Green Beautiful

Appendix D: Design recommendations.

1. Increase the space's perceived naturalness by diversifying the type of vegetation and location of planting.

2. Use portable container planting to extend vegetated areas beyond the green roof's borders.

3. Increase user's sense of connection to nature by reducing the green roof's "unnatural" elements and adding informational signage that describes planting and green roof amenities.

4. Add covered areas and protective canopies to improve green roof usage during winter months.

5. Add easily visible waste receptacles.
