

Assessment Of the Impact of Landscape Slope Design on Human Stress & Comfort Level in Caleb University, Imota, Lagos

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Abstract- Landscape design plays a critical role in shaping human experience within university environments, particularly in hilly terrains where daily movement can influence stress and comfort levels. While previous studies have emphasized accessibility, walkability, and aesthetics, limited attention has been given to slope treatment as a factor affecting psychological well-being. This study examines the relationship between landscape slope design and perceived stress and comfort among users at Caleb University. A quantitative method approach was adopted, using structured questionnaires to assess user perceptions and behaviors. The findings indicate that steep gradients, poor surface conditions, and high visual exposure increase anticipatory stress and avoidance behavior, while gentle slopes and well-designed pathways enhance comfort and usability. The study provides evidence-based recommendations for improving campus landscape design to promote accessibility, reduce stress, and enhance overall user experience.

Keywords: Landscape Design, Perceived Stress, Psychological Comfort, Slope Treatment, University Campus, User Perception

I. INTRODUCTION

1.1 Background of Study

University campuses are complex spatial environments where physical design significantly influences movement, interaction, and psychological well-being. At Caleb University, the predominantly hilly terrain presents unique challenges for daily navigation, as students and staff regularly encounter steep slopes, uneven surfaces, and varying levels of visual exposure. These features not only affect physical accessibility but also shape anticipatory stress and comfort levels.

One prominent example is the main entry road, which involves a steep descent upon entering the campus and a corresponding ascent when exiting. This spatial configuration, combined with the visual perception of elevation changes across campus buildings, can create anticipatory stress as users perceive the physical effort required before engaging with the terrain. Similarly, the pathway linking the administrative building to the architecture building includes a steep descent with partially unpaved sections, discouraging use and prompting avoidance behavior.

Additionally, the sloped grassy area in front of the architecture building serves as an informal shortcut, illustrating how users adapt their movement patterns in response to slope conditions. These examples highlight the influence of slope gradients, surface types, and spatial arrangement on pedestrian behavior and experience.

Although landscape design research has extensively explored walkability, aesthetics, and restorative environments, slope treatment remains underexamined as a determinant of psychological comfort. In hilly environments, slope characteristics such as gradient, width, surface texture, and visibility can significantly influence perceptions of safety, effort, and usability. Steep or poorly designed slopes may induce stress, hesitation, and fatigue, whereas well-designed slopes can facilitate movement and enhance comfort.

This study therefore investigates how landscape slope design affects perceived stress and psychological comfort at Caleb University, linking physical

characteristics of slopes with user perceptions and behavior.



Fig. 1.1: Aerial view of Caleb University showing terrain

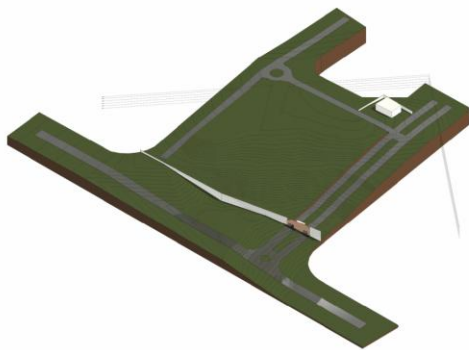


Fig. 1.2: 3D model of Caleb University entry area showing steepness

1.2 Objectives of the Study

The objectives of this study are to:

- Examine the physical characteristics of slopes, including gradient, surface type, width, and visual exposure
- Assess perceived stress levels associated with navigating different slopes
- Evaluate user comfort in relation to slope design features
- Analyze behavioral responses such as route selection and avoidance
- Establish relationships between slope design, stress, comfort, and movement patterns

1.3 Significance of the Study

Why does this matter? First, because well-being on campus is not just about classrooms and counselling services. It is also about the physical environment. A campus that stresses people out before they even reach their destination is not fully supporting its users.

Second, because slope design is often an afterthought. Engineers calculate maximum gradients for accessibility codes. Architects place buildings on the most buildable ground. But很少有人 asks: what is it like to walk this slope every day, in the heat, carrying a backpack, maybe already tired?

Third, because the findings from Caleb University can apply elsewhere. Many universities in Nigeria and beyond are built on hilly terrain. The same principles apply to urban parks, hospital grounds, and residential developments. Slope design is a universal issue, but it is rarely studied as a psychological one.

This study provides evidence-based recommendations that campus planners, architects, and facility managers can use right away: better surface finishing, visual buffers, gentler gradients where possible, and alternative accessible routes.

1.4 Theoretical Framework

Three theories guided this study.

Attention Restoration Theory (Kaplan & Kaplan, 1989) says that well-designed environments can reduce mental fatigue. Nature, green space, and visually coherent settings help people recover from cognitive overload. But what about slopes? A slope that is stressful to navigate might undermine that restorative potential. A well-designed slope—with pleasant views, resting points, and manageable gradient—might actually enhance it.

Cognitive Appraisal Theory (Lazarus & Folkman, 1984) explains how people evaluate environmental challenges. Before you even start walking up a steep slope, you look at it and think: "That looks hard." That is anticipatory stress. The steeper the slope looks, and the more of it you can see from the bottom, the more stress you feel. This is not irrational. It is a normal cognitive appraisal process.

Affordance Theory (Gibson, 1979) asks: what does the environment offer or allow? A gentle paved slope affords easy walking. A steep uneven slope affords hesitation, careful foot placement, and maybe avoidance. Slope characteristics either enable or constrain action.

Together, these theories help us interpret why people react the way they do to different slope designs.

II. LITERATURE REVIEW

2.1 Campus Landscape Design and Well-Being

There is good evidence that well-designed campus environments improve psychological well-being. Green space, coherent pathways, comfortable resting areas—these all help (Kaplan & Kaplan, 1989). The reverse is also true. Poorly designed environments—confusing layouts, neglected maintenance, physically demanding terrain—increase fatigue and stress.

On a hilly campus, the interaction between buildings and natural topography becomes critical. A slope that is steep, uneven, and visually exposed can turn a routine walk into a daily source of strain. Over time, that strain accumulates. Users may start avoiding certain routes altogether, which means they use the campus less fully. Some studies have even linked environmental quality on campus to job performance and academic outcomes (Adeyemi et al., 2024; Ademakinwa et al., 2024). If poor housing affects performance, then poor slope design probably does too.

2.2 Slope Design and Pedestrian Experience

Slope gradient and surface type matter a lot. Steep or uneven slopes increase physical effort and perceived risk. People avoid them. Gentle slopes encourage movement and improve accessibility.

Ogunnaike et al. (2025) argue that circulation design—whether corridors, stairs, or sloped pathways—should be seen as an active contributor to well-being, not just connective infrastructure. A well-designed slope might include switchbacks to reduce effective gradient, textured paving for grip, intermittent landings for rest, and vegetation buffers to screen the full intimidating view. These are not

luxuries. They are design strategies that make walking feasible and comfortable.

2.3 Psychological Responses to Environmental Stressors

Why does a steep slope cause stress? Not just because it is physically harder. Stress comes from cognitive appraisal. The user looks at the slope and judges whether their physical capacity, time, and energy can handle it. If the judgment is "this is too much," stress follows.

Visual exposure plays a big role here. A slope that is fully visible from its base—like Caleb University's main entry road—lets the user preview the entire effort before starting. That preview can trigger hesitation, increased heart rate, muscle tension, and even outright avoidance. A slope that is partially screened by vegetation or broken into visible segments with landings reduces that anticipatory stress. You cannot see the whole difficult experience at once, so it feels more manageable.

Surface conditions also matter. Uneven, cracked, or unpaved surfaces signal unpredictability and risk. Each footstep becomes a potential hazard. That increases cognitive load and accelerates mental fatigue. Over repeated exposures, poorly designed slopes can condition negative emotional responses: dread, frustration, resignation.

2.4 User Behavior and Route Choice

Pedestrians make constant micro-decisions. On flat terrain, the shortest path usually wins because the cost of extra distance is low. On hilly terrain, the calculus changes. People will trade distance for reduced gradient. They will walk 200 metres extra to use a switchback path instead of a steep cut-through.

This study's findings confirm that pattern. A majority of respondents reported frequently choosing alternative routes to avoid steep or risky slopes. That avoidance behaviour, while rational, has side effects: underutilization of certain facilities, congestion on preferred routes, and reduced spatial equity for users with limited alternatives.

What determines whether a slope gets avoided? Gradient matters, but so does surface quality, visual exposure, and the presence of resting points, shade, and handrails. A slope that feels manageable in a group might feel intimidating when alone. A slope that is tolerable when you are not in a hurry might be unacceptable when you are running late. Designers need to think holistically.

2.5 Research Gap

Most pedestrian comfort studies assume flat or gently sloping urban settings. Elevation change is treated as a minor nuisance, not a central design challenge. Campus walkability research prioritises path connectivity, sidewalk width, shade, seating, and safety from traffic—but rarely isolates slope gradient, surface condition, or visual exposure as independent variables.

Where slopes are mentioned, they are often conflated with stairs or ramps in accessibility codes. The focus is on regulatory compliance (maximum gradient percentages), not on the psychological experience of navigating a sloped landscape repeatedly over time. This study addresses that gap directly. We treat slope design as a distinct variable affecting perceived stress, comfort, and behaviour. We provide empirical evidence linking specific design features to measurable outcomes.

III. METHODOLOGY

3.1 Research Design

We used a quantitative research approach. Why? Because we needed to measure perceived stress, comfort levels, and behavioural responses across a sample of campus users in a systematic, comparable way.

1. A cross-sectional design captured user perceptions at a single point in time. That is appropriate for an exploratory study aimed at establishing baseline relationships. Structured surveys allowed efficient data collection from a larger sample while maintaining consistency.
2. We included a small number of open-ended response options to capture unanticipated themes. So the design is quantitative-dominant with some qualitative nuance.

3.2 Study Area

Caleb University, Imota, Lagos, sits on predominantly hilly terrain. Academic buildings, administrative offices, hostels, and dining facilities are spread across different elevations. That means students, faculty, and staff navigate slopes repeatedly every day.

We selected four specific slope locations after preliminary site reconnaissance and consultation with frequent campus users:

1. Main entry road: A steep descent (approximately 12–15% gradient) upon entering the campus and a corresponding ascent when exiting characterized by fully paved but visually exposed conditions with no intermediate resting points
2. Administrative-to-architecture pathway: A steep descent (approximately 10–12% gradient) with partially unpaved sections (approximately 30% of length), inconsistent surfacing, and no handrails or edge definitions.
3. Sloped grassy area in front of architecture building: An informal shortcut (approximately 8–10% gradient) lacking formal pathway treatment, used primarily by architecture students despite its unpaved, often muddy condition.
4. Cafeteria-adjacent pathways: Moderate slopes (5–8% gradient) intersecting with high pedestrian volumes during meal times (12:00–14:00 and 17:00–19:00), with mixed surface conditions (paved but uneven in sections).

Each location represents a different combination of gradient, surface type, width, visual exposure, and surrounding land use. That allowed comparative analysis across slope types while holding broader institutional variables constant.

3.3 Population and Sampling

Target population: students and staff who regularly use campus pathways. Frequent exposure is necessary for stable, reliable perceptions of stress and comfort.

We used purposive sampling. This is appropriate when the researcher seeks participants with specific,

relevant experience, rather than statistical representativeness. Sample size: 60 respondents. That is adequate for detecting meaningful patterns in descriptive quantitative analysis, consistent with similar published studies (typical samples range from 50 to 150 for single-site investigations).

We intentionally recruited across categories: undergraduate students (~40), postgraduate students (~10), academic staff (~5), administrative/support staff (~5). Gender balance was considered. We also made efforts to include users who traverse different slope locations regularly.

3.4 Data Collection

We used structured, self-administered questionnaires. The instrument had four sections:

1. Demographics (age, gender, user category, frequency of campus navigation)
2. Perception of specific slope characteristics (gradient, surface, visual exposure, width, edge definition)
3. Psychological and behavioural responses (hesitation, anticipatory stress, avoidance, route selection)
4. Overall comfort assessment and suggested improvements

We used five-point Likert scales extensively ("Strongly Disagree" to "Strongly Agree", or "Never" to "Always"). The questionnaire was pre-tested with five campus users, and minor revisions were made.

Data collection took two weeks during regular academic sessions. We distributed paper questionnaires at high-traffic locations (cafeteria entrance, library foyer, architecture building lobby) and shared a digital link via departmental email lists and WhatsApp groups. Total valid responses: 60. Response rate: approximately 85% among those approached.

3.5 Data Analysis

We used descriptive statistical methods: frequency distributions, percentages, mean scores, cross-tabulations. Likert-scale responses were treated as ordinal data. Frequencies were calculated for each response category.

Cross-tabulations explored relationships between variables (e.g., avoidance behaviour across different

user groups or slope locations). We triangulated quantitative findings with open-ended responses and field observations to identify coherent patterns.

Thematic analysis was applied to open-ended suggestions for improvement. Responses were coded into categories (e.g., "gentler gradients," "improved surface finishing," "visual buffers"). All analyses used Microsoft Excel and IBM SPSS (Version 26).

3.6 Ethical Considerations

Participation was voluntary. Informed consent was obtained from all respondents before data collection. Respondents were informed they could withdraw at any time without negative consequences. No invasive procedures, deception, or experimental manipulation were involved. Risks were assessed as minimal.

IV. RESULTS AND DISCUSSION

We present findings from 60 respondents. The results show a strong relationship between slope design and user experience.

4.1 Perceived Stress and Slope Conditions

Figure 4.1: "Uneven or exposed surfaces make me hesitant to use certain slopes"

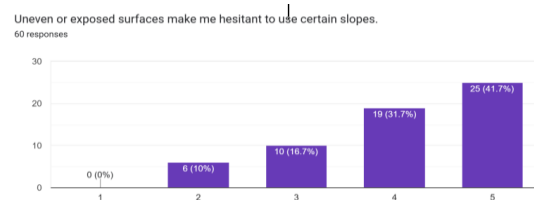


Figure 4.1 presents responses to the statement: "Uneven or exposed surfaces make me hesitant to use certain slopes"

Over 70% of respondents agreed or strongly agreed that uneven or unpaved surfaces trigger hesitation. Surface condition, in other words, is a major contributor to perceived stress. It often outweighs gradient alone in influencing whether people will use a slope. From an affordance perspective (Gibson, 1979), uneven surfaces signal reduced walkability and increased risk, prompting caution or avoidance.

Figure 4.2: "I often choose alternative routes to avoid steep or risky slopes"

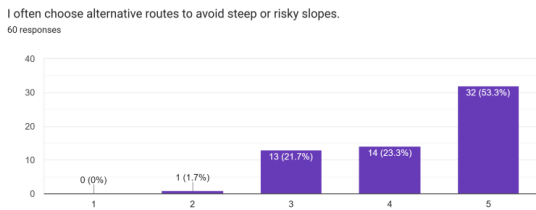


Figure 4.2 responds to: "I often choose alternative routes to avoid steep or risky slopes."

Approximately 65% of respondents reported frequently selecting alternative routes to avoid challenging slopes. This confirms the pedestrian behaviour literature: people actively trade distance for reduced effort and perceived safety. Avoidance behaviour was especially pronounced among respondents who navigate campus daily or multiple times daily, suggesting cumulative fatigue influences route decisions.

Figure 4.3: "Not being able to see the full slope before you start makes it feel less stressful or easier to walk"

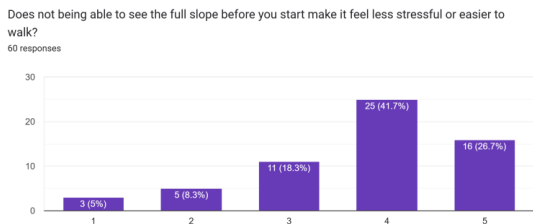


Figure 4.3 addresses: "Does not being able to see the full slope before you start make it feel less stressful or easier to walk?"

About 60% agreed that limited visibility of the full slope reduces perceived stress. This highlights the role of visual exposure in anticipatory stress (Lazarus & Folkman, 1984). When users cannot fully preview a slope's extent, they cannot pre-evaluate the total effort required. Paradoxically, that reduces stress by preventing cognitive overload. This supports design strategies like curved pathways, level breaks, and vegetative screening that segment slope visibility.

4.2 Overall Comfort and Suggestions

Figure 4.4: "Overall, I feel comfortable using campus slopes"

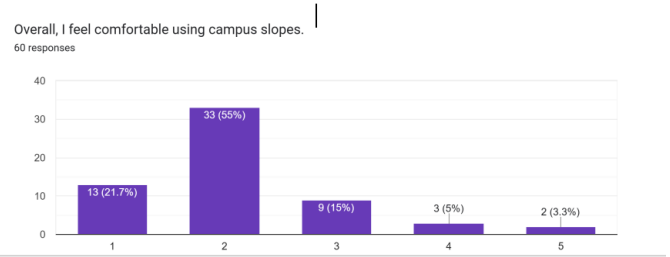


Figure 4.4 summarizes responses to: "Overall, I feel comfortable using campus slopes."

Seventy-seven percent disagreed or strongly disagreed. Fewer than one in four users report basic comfort navigating the campus terrain. That is striking. Widespread discomfort has implications beyond individual experience: campus satisfaction, punctuality (due to route diversion), and physical activity levels may all suffer.

Figure 4.5: "The slopes encourage smooth and efficient movement around campus"

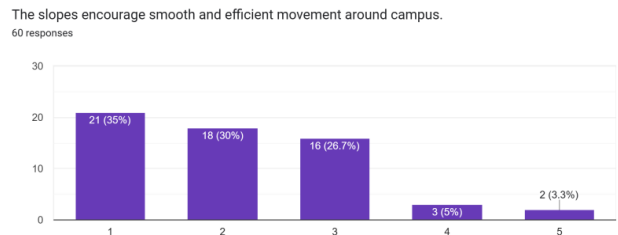


Figure 4.5 presents responses to: "The slopes encourage smooth and efficient movement around campus."

Most respondents disagreed. Current slope design acts as a barrier, not an enabler. Smooth, efficient movement—consistent pace, minimal hesitation, direct route adherence—was notably absent on steep, uneven, or visually exposed slopes. Instead, respondents described stop-start movement, careful foot placement, and active route monitoring.

Table 4.1: Preferred Improvements

Proposed Improvement	Percentage of Respondents
Gentler slope gradients	30.0%
Improved surface finishing	50.0%
Addition of steps/ramps	5.0%
Visual buffers/landscaping	6.7%
Handrails/support features	1.7%
Resting spaces along slope	3.3%
All of the above	3.3%

Improved surface finishing was the most frequently requested intervention (50%), followed by gentler gradients (30%). These align closely with the sources of stress identified earlier. Notably, only 1.7% requested handrails. That suggests users prioritise fundamental redesign (surface and gradient) over ancillary safety features.

V. CONCLUSION, LIMITATIONS AND RECOMMENDATION

5.1 Conclusion

This study set out to answer a simple question: how does landscape slope design affect perceived stress and comfort at Caleb University?

The answer is clear. Poorly designed slopes—steep gradients, uneven or unpaved surfaces, high visual exposure—create real barriers to movement. They increase anticipatory stress. They trigger avoidance behaviours. They disrupt efficient campus navigation. Well-designed slopes do the opposite. Gentle gradients, continuous slip-resistant surfacing, visual buffers, and periodic resting points promote accessibility, enhance user satisfaction, and support psychological well-being.

These findings align with existing theories of environmental stress, affordances, and restorative environments—but apply them specifically to the underexplored context of sloped landscapes in higher education.

The implication is straightforward: slope treatment should not be an afterthought in campus planning. It should be a central design consideration. By prioritising slope-sensitive strategies, universities can transform challenging topography from a source of daily strain into an asset that supports movement, comfort, and inclusivity for all users.

5.2 Limitations

This study has limitations. The sample size is relatively small (60 respondents). The focus is on a single institution (Caleb University), so findings may not generalise directly to other campuses with different topographical, climatic, or cultural contexts. Purposive sampling does not allow statistical generalisation to the broader university population. The cross-sectional design captures perceptions at one point in time, leaving longitudinal questions unanswered.

Future research should address these limitations by employing larger, randomly sampled populations; conducting comparative studies across multiple campuses; and incorporating longitudinal or quasi-experimental designs to establish causal relationships between specific slope interventions and changes in user stress and behaviour.

5.3 Recommendations

Based on the findings, we propose the following evidence-based recommendations:

1. Introduce gentler slope gradients in high-traffic areas. A majority of respondents reported increased stress and hesitation on steep slopes. Where gradient reduction is impossible due to topographical constraints, consider switchback pathways or terracing to effectively moderate steepness.
2. Improve surface quality and continuity. Uneven or unpaved sections were strongly associated with hesitation and route avoidance. Prioritise slip-resistant, well-drained, consistently maintained paving materials on all formal pedestrian slopes.

3. Incorporate visual buffers. Landscaping, level breaks, or curved pathways reduce anticipatory stress caused by full slope visibility. Screening the full extent of a slope limits cognitive appraisal of total effort, making the ascent or descent feel more manageable.
4. Provide alternative accessible routes. Ramps and stepped pathways accommodate different user preferences, fitness levels, and mobility needs. Multiple route options empower users to choose paths aligned with their comfort and time constraints.
5. Enhance pedestrian support features in steeper areas. Handrails, edge definitions, and intermittent resting landings improve perceived safety and usability, particularly for users with mobility challenges, heavy loads, or balance concerns.

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