Journal of Management and Planning Research
2024, 1(1), 1-16

INNOVATIVE CAMPUS SPACE PLANNING AND MANAGEMENT STRATEGIES BASED ON STUDENT–COMMUNITY INTERACTION MODELS

Patsy Healey

In today's higher education landscape, campus space design is more than a response to learning and living needs—it is also a key driver of meaningful teacher–student engagement and a stronger campus community. Yet many conventional campus plans prioritize functional layouts while giving limited attention to social interaction and psychological belonging, leading to a mismatch between built environments and real user expectations. This study proposes a set of forward-looking planning and administrative strategies grounded in a student–community interaction framework. By introducing the concept of a "molecular unit," it connects teaching spaces, residential areas, and community services into an integrated system that encourages closer teacher–student communication. It further recommends building a coordinated campus–city linkage mechanism to promote shared resources and expand opportunities for social practice. In parallel, the creation of event-oriented spaces and a distinctive "spirit of place" is emphasized to strengthen identity and belonging among both students and staff. The study also advances a hybrid living concept aimed at reducing everyday barriers between students and instructors and enriching campus experience. Overall, these findings support spatial innovation and cultural development in higher education and provide both theoretical grounding and practical direction for future campus design.

Index Terms — campus space design, student community interaction, spirit of place, campus-urban interaction, mixed housing

INTRODUCTION

A university campus is not only a setting where students reside and pursue their studies; it is also a central arena for interaction, communication, and the cultivation of a shared community between faculty and students within today's fast-changing higher-education landscape [1]. As social conditions evolve and models of talent development continue to shift, universities encounter both new possibilities and new constraints in campus planning and governance. In this context, the student community interaction model has stimulated more innovative approaches to campus spatial design, making it a major focus of contemporary campus planning [2]. Beyond arranging space for functional efficiency, this design perspective emphasizes psychological belonging and social connection among teachers and students, thereby supporting the long-term sustainability of campus culture.

The concept of building campus communities originates from broader community-building theory, which centers on strengthening interpersonal relationships to create coherence and a sense of belonging within a place [3]. Applying this concept to campus spatial design requires moving beyond traditional, purely physical planning toward a comprehensive human-centered approach. Such an approach involves not only optimizing the built environment and spatial layout, but also enhancing social organization and the structuring of everyday activities. Consequently, community-oriented campus planning has steadily gained influence and has become an important research direction within international higher education [4]. By adopting this perspective, colleges and universities can better integrate diverse needs—including teaching, living, culture, and service—while also encouraging productive connections between campus life and the surrounding city, helping society recognize the multiple roles higher education plays today.

Nevertheless, many challenges remain in current campus layouts. Conventional planning often favors "technology-sensitive" or "will-sensitive" schemes that overemphasize the arrangement of physical space while paying insufficient attention to how students and faculty interact [5]. This top-down planning mode frequently lacks flexibility and struggles to respond to the diverse needs of teachers and learners. Moreover, campuses are no longer isolated learning enclaves; under globalization they function more like living systems that must interact closely with their urban contexts. For this reason, it has become essential to embed the community concept into campus design so that campus environments can better support teacher–student interaction and strengthen a sense of belonging [6, 7].

Research on campus community development has advanced both conceptual frameworks and practical guidance. Many scholars argue that strengthening the overall linkage between universities and surrounding urban communities can significantly enhance the campus's social role. At the same time, creating event-oriented spaces and cultivating a sense of place are widely seen as effective ways to reinforce the psychological identification of educators and learners [8]. A campus should therefore be more than a place to live and study; it should also embody cultural meaning and a distinctive sense of place. This implies that campus design must consider psychological identity and belonging alongside the physical configuration of buildings and open spaces. When campus environments are thoughtfully designed, teachers and students can experience a unique cultural and spiritual atmosphere in daily learning and living, which in turn reinforces affiliation with the institution [9, 10].

Despite these insights, practical shortcomings persist in many contemporary design schemes. On the one hand, traditional functional zoning is often too rigid and overlooks the varied demands of faculty and students. For example, separating residential and instructional areas can reduce everyday opportunities for teacher–student contact, weakening the vitality of campus life [11]. On the other hand, modern public-space design frequently prioritizes formal aesthetics and basic utility while underestimating the social and interactive purpose of shared spaces. When public spaces lack adaptability and diversity, they struggle to meet the increasingly complex requirements of meaningful teacher–student engagement.

To offer new ideas and operational pathways for campus planning, this paper proposes a systematic set of design and management strategies grounded in innovative campus spatial design informed by the student community interaction model. Compared with conventional campus design approaches, the work provides several notable advantages.

First, this study introduces the concept of the "molecular unit" in campus space: a multifunctional and dynamic setting for teacher–student engagement created by organically integrating living, learning, and community service facilities. Through a flexible spatial structure, this approach supports interaction, reduces barriers created by traditional functional divisions, and strengthens students' identity and sense of belonging.

Second, the paper proposes a comprehensive interaction mechanism between the university and urban society by optimizing institutional and spatial arrangements, aiming to promote energy exchange and resource sharing between campus and city. Implementing this mechanism can enhance the university's urban influence while improving student development and expanding opportunities for social participation.

Third, the construction of event spaces and the cultivation of a spirit of place through intentional spatial organization form a central emphasis of this work. The objective is to shape the campus into an environment where teachers and students can communicate, collaborate, and learn from one another, thereby strengthening psychological identity and cultural belonging in both academic routines and everyday life.

Finally, the study advocates mixed housing by incorporating faculty residences into campus molecular units, increasing the likelihood of frequent and informal encounters between instructors and students. In addition to improving spatial organization, this strategy enriches campus vitality by creating more everyday opportunities for teacher–student interaction.

FORMATION OF THE CAMPUS COMMUNITY-BUILDING CONCEPT

The Concept of a Campus Community

A core aim of community-oriented development is to foreground interpersonal ties and to shape environments where people experience strong connection, mutual recognition, and cohesion. In the university context, *campus community building* refers to the practical creation of a human-centered campus environment characterized by belonging, shared identity, and close linkage with the surrounding urban community. This approach strengthens the campus as a distinctive community by emphasizing the roles of teachers and students, refining the campus system at multiple levels (including social organization, everyday life and activity patterns, and spatial/morphological form), and identifying and reinforcing key campus elements [12].

From the perspective of planning practice, community-oriented campus development can be viewed as an extension and enhancement of conventional campus planning: it is a culture-driven form of spatial making that embodies people-centered values and encourages coordinated advancement across campus culture, technology, and economy, as well as campus form and space. In many current projects, however, campus spatial-environment design tends to be "technology-sensitive" or "will-sensitive": it is largely top-down, shaped by administrative intention and market logic, and it prioritizes physical layout as the dominant concern, often using a phased, closure-oriented implementation model [13, 14].

By contrast, campus community building aligns with a "humanistic sense of life" and typically proceeds through a gradual, iterative pathway that integrates top-down guidance with bottom-up participation. It places stronger weight on the multi-layer needs and development of the campus population, treating constructive interaction between campus social space and campus physical form as a principal objective, among other

Table 1: Key differences between conventional campus spatial-environment planning and campus community-oriented spatial-environment design.

Content	Conventional Campus Spatial-Environment Planning	Campus Community Spatial-Environment Design
Value subject	Management and market orientation	Teachers and students as primary stakeholders
Operational character	Technology-driven or will-driven	Humanistic, experience-oriented
Operational method	Top-down material-space determinism	Joint bottom-up and top-down approach with multiple considerations
Process features	Phased delivery with completion/closure	Continuous, progressive, and transparent
Participants	Authorities and designers	Government, educators, faculty, designers, and broader social forces
Primary goal	Emphasis on economic/financial return	Meeting multi-level human needs through campus life and environmental benefits
Main form	Physical/material form space	Positive coupling of material form space and social space
Theoretical basis	Functionalism-dominant frameworks	Community, communication, sustainability, and related theories

priorities [15]. In essence, introducing the community concept into campus design addresses the limitations of traditional practice—especially the neglect of campus culture, campus spirit, and the centrality of teachers and students—and responds to societal demands arising from reforms in contemporary talent-education systems. Table 1 summarizes the main differences.

Constituent Elements of Campus Community Building

This paper argues that campus planning and design should be guided by community-based thinking. On one side, this orientation supports the effective formation of a campus community and helps connect the university more closely with its surrounding society. On the other side, viewed from the internal logic of campus construction, it offers a perspective that enhances the social meaning of architecture and encourages harmonious development of individuals, and of individuals in relation to society. By adopting a campus-community lens to steer planning and design, the university's humanistic spirit can be transformed from an abstract ideal into a tangible spatial-environment system. The main components are summarized below.

To move from a conventional campus toward a functioning campus community, it is necessary to adjust existing campus structures and explore flexible community configurations that (i) stimulate creativity and participation among most campus users, (ii) connect smoothly with the urban environment, and (iii) foster pride and belonging among students. In addition, planners should account for how education-system reforms reshape university planning and development, how communities influence talent-training expectations, and how these forces can provide lessons and reference cases for future campus construction.

Historically, many university campuses operated as relatively closed systems with limited external contact. With contemporary social and economic transformation, universities can no longer remain insulated from the city; instead, they increasingly interact with and become embedded in their local communities. Achieving substantive campus–society connection requires more than physical channels that enable flows of people, resources, and activities; it also depends on institutional arrangements that support sustained interaction

between universities, cities, and communities.

A widely discussed idea in architecture and urban studies is that psychological identity—for cities and for buildings—helps people inhabit the world meaningfully. Identity, in this sense, emerges when individuals experience their surroundings as significant and when they maintain meaningful relations with the outside world. Thus, people rely not only on sensory perception but also on cognition and interpretation to recognize the distinctive patterns and qualities of their environment. A campus with a recognizable *spirit of place* can strengthen belonging because teachers and students participate in it both physically and mentally.

Place, moreover, is formed through memory and emotion via connections to events that shape the built environment (such as building practices and everyday living behaviors). This differs from a purely physical notion of space or from natural setting alone. From a phenomenological viewpoint, the foundational value of place lies in enabling people to live in the world while grasping the meaning of both the world and themselves. Accordingly, cultivating campus spirit of place aims to help educators and learners perceive the overall atmosphere of campus life through spatial form and through the meanings attached to studying, living, and working in concrete settings. Norberg-Schulz emphasized that the designer's task is to make the spirit of place legible by creating spaces that are both pleasant and meaningful; in this sense, developing campus intention and place spirit is integral to forming a campus space environment within a community framework [16].

Research on campus life should begin with its primary subjects—teachers and students—and examine their daily practices (learning, research, dining, gathering, and related routines), along with behavioral and psychological traits and the ways these interact with the surrounding environment. Among the most critical patterns to understand is teacher–student interaction, which expresses the broader logic of social relations within the campus community. A classic sociological insight is that society is constituted by relationships rather than by individuals in isolation; likewise, the vitality of campus life depends on the connections formed among its members. Therefore, a decisive measure of whether community thinking is effectively integrated into campus design is the degree to which the campus environment can encourage spontaneous communication among students, among teachers, and between teachers and students across both formal and informal activities. Campus community building thus places special emphasis on spaces that support interaction among campus subjects.

A community is ultimately characterized by members' sense of belonging and cohesion. Sociological perspectives (e.g., Inkers) suggest that the core of community lies in camaraderie among members and in shared understandings of material and spiritual aspects of life. Maintaining and developing a community, therefore, depends on inheriting and reinforcing belonging while continuously supporting growth; in this view, sustaining an existing community and building a new one converge on the same task: nurturing a durable sense of community. Teachers and students who recognize and participate in the campus community develop belonging through shared concerns, interests, and emotional resonance generated by joint involvement in campus affairs. This depends, in part, on identification with the campus spatial environment and on the development of campus life and spirit of place.

Campus culture is formed through ongoing creation and evolution. With faculty, staff, and students as its main carriers, and campus spirit as its core, campus culture reflects collective attitudes, values, and practices within the institution. It can be understood as comprising material culture and spiritual culture. Material culture is expressed through spatial materialization—the university's natural and built environment—and is relatively visible. Spiritual culture is more implicit, grounded in scientific and humanistic ideals, and driven by internal motivation. Campus culture, shaped through practice, historical accumulation, selection, and refinement, becomes the essence of university identity and a key driver of community feeling: a clearer and more distinctive culture tends to strengthen belonging and cohesion, while strong community identification can, in turn, reinforce cultural development.

Campus life and environment, activities and events that embody collective identity, and the spatial/formal characteristics of physical settings are all important carriers of campus culture and spirit. Consequently, design elements that support community feeling should be distilled from representative events and practices. When identifying campus spatial components, planners should also consider local symbols and customary forms familiar to users. While the image of physical space contributes to forming and sustaining campus culture and spirit, cultural life and interpersonal interaction are equally essential; together, these forces shape the growth and continuity of campus culture.

FUNCTIONAL ZONING OF THE CAMPUS

As universities become more closely connected with surrounding communities and as construction and governance systems evolve, contemporary campuses are taking on expanded roles. Based on field investigations, comparisons of several older and newer campuses, and a review of related studies, it is evident that many newly developed campuses continue to rely heavily on spatial partitioning. Using the University of California, Berkeley as an illustrative case (see Fig. 1), the campus is typically organized into the following zones: (1) *Core area*: a central district that supports external communication and public activity, including administrative offices, libraries, information-exchange centers, training facilities, laboratories, and other shared-use spaces. These areas primarily support campus management, campus–society connections, information collection and exchange, and public participation in campus activities. (2) *Teaching zone*: departments and colleges are grouped to form an organized and coherent instructional environment. Consolidated learning spaces can help students build systematic knowledge structures, promote interdepartmental exchange, and reinforce the distinctive character of academic life. (3) *Sports zone*: alongside standard athletic fields, many campuses include gymnasiums, swimming pools, and courts for basketball, volleyball, and badminton, among other recreational facilities. Influenced by national fitness initiatives and a growing emphasis on holistic student development, universities increasingly strengthen sports and cultural events, and the proportion of land dedicated to athletics has steadily increased. (4) *Residential zone*: with the apartment-style transformation of student housing and the socialized/group-based management of campus services, some campuses show trends such as the outward expansion of residential functions, the relative weakening of on-campus living areas, and the diversification of accommodation forms (e.g., high-, mid-, and low-rise typologies). This zone typically includes dormitories, dining facilities, and supporting services. (5) *Science and technology park*: under market-economy conditions and the intensification of science and technology as productive forces, universities increasingly extend their original research and development functions to establish more independent science and technology parks. (6) *Public green space*: commonly designated in zoning plans, these areas improve campus environmental quality and contribute to students' living conditions. In addition, the roadway system that links these functional zones is a key element of campus partitioning.

Research on the "Molecular Unit"

The "molecular unit" refers to the basic building block of a polycentric molecular structure for the campus community. It embodies the idea of a *sub-community* and functions, in essence, as a neighborhood where learning and living occur together—a "living–learning" district. Unlike conventional campus planning that separates teaching, residential life, sports, and staff functions into distinct areas, the molecular-unit concept emphasizes the diversity of community members and promotes the co-location of students and teachers from different majors and grade levels within an integrated set of teaching, residential, and community-service facilities. Ideally, the unit is pedestrian-oriented and forms a relatively complete micro-environment, as conceptually shown in Fig. 2.

Figure 1: University of California, Berkeley campus (schematic zoning example).

Figure 2: Conceptual model of a campus molecular unit.

As the smallest unit within a spatial system, a molecular unit shares key attributes with complex social communities. Its complexity is expressed in two main ways. First, it aggregates social, functional, cultural, and spatial meanings into a composite whole, exhibiting multi-dimensional and mixed-use characteristics. In physical form, the unit contains multiple spatial types—such as residential space, shared/public space, circulation paths, and instructional space. Second, from a structural viewpoint, molecular units display layered organization and clearly articulated relationships among different spatial components, each with its own morphology and structural logic. In this sense, even a small unit can constitute a complete and sophisticated spatial system.

Homogeneity within molecular-unit space arises from two sources. On one hand, many units share similar morphological elements, including texture, spatial pattern, detailing, building typologies, materials, color systems, and symbolic themes. On the other hand, comparable compositional features can be observed across different scales of unit aggregation. This isomorphic tendency is typically rooted in similarities in the campus social structure and in resident activity patterns. It should be noted, however, that molecular units of different sizes do not necessarily exhibit simple or directly visible structural uniformity; because unit-space patterns are often intricate, homogeneity may be implicit, weakened, or difficult to identify.

On this basis, the study supports a *mixed-housing* approach in which selected faculty apartments are treated as part of the campus community's molecular unit, with the aim of increasing teacher–student contact and enhancing overall campus vitality. Here, "mixed living" does not mean simply placing faculty and

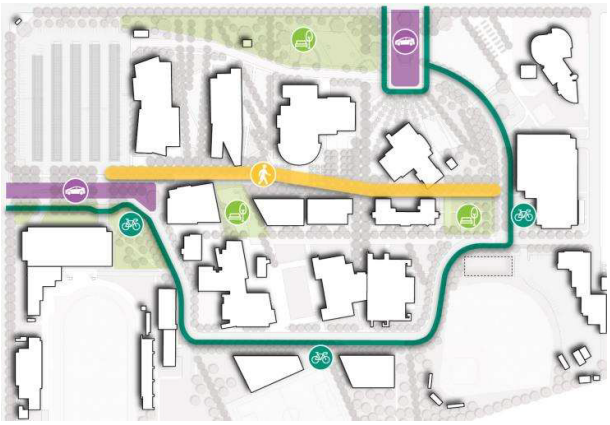

Figure 3: Public-space management and use example associated with the University of Virginia (schematic).

students in the same building, which may be impractical given differences in population structure, lifestyles, and daily routines. Rather, it refers to organizing faculty apartments by academic groups or colleges and locating them within specific molecular units—particularly apartments for single faculty—so that they form semi-independent clusters while sharing selected common areas and daily-life facilities with students. This increases overlap between living territories, supports more spontaneous encounters, and introduces new patterns of public-space use within the unit, thereby diversifying spatial activities. There are precedents for this idea, such as planning concepts associated with the University of Virginia (Fig. 3), where student housing is arranged near faculty residences as a continuing strategy to encourage everyday interaction.

Spaces Accessible Within the Molecular Unit

Daily university life—eating, sleeping, studying, and extracurricular activity—largely unfolds within public or semi-public settings. In this sense, the public character of campus life provides the foundation for the public nature of molecular-unit space. A molecular unit's shared areas become vibrant primarily because of the diversity of activities that they can accommodate. Three aspects are particularly important.

(1) Diversity of activity places. The unit should include multiple kinds of settings for interaction and activity, such as plazas, green lawns, small lakes, tree-lined boulevards, and other gathering spaces. These can range from "static" interaction areas near building edges to "dynamic" interaction corridors formed by paths that connect different sub-areas, and further to composite public spaces where multiple activities overlap. Supplementary features such as pergolas, flower structures, and shaded pockets can enrich micro-experiences. In addition, to address varied behavioral-psychological preferences, the unit may provide a spectrum of quiet recreational facilities (e.g., table tennis, billiards, small lounges) with rest amenities arranged to minimize disturbance to teaching activities. Berkeley's student-center surroundings (Fig. 4) provide an illustrative example of activity clustering.

(2) Diversity of use across time and groups. Public space should support different user needs at different times of day and under different weather conditions. For instance, a lawn or small lake can serve as a pleasant morning study area, while covered or sheltered edges can accommodate conversation and observation during rain, and small, secure, calm zones can support quieter evening use. The objective is to construct a public-space system with adequate variety across places, activities, and times so that multiple groups can find suitable settings without conflict. When activities interweave across space and time, the attractiveness of public space increases, and users are more likely to develop identity and belonging within the unit. This can also motivate teachers and students to participate more actively in stewardship and development of the

Figure 4: Activity patterns near the UC Berkeley student center (schematic example).

molecular unit and, by extension, the broader campus.

(3) Accessibility and support systems. Vitality also depends on easy access and on the completeness of supporting amenities. “Ancillary facilities” include seating, waste bins, lighting, and other basic elements required for comfortable use of lawns, plazas, and sports micro-spaces. Humanizing design also includes paving choices, color and form considerations, and barrier-free provisions (e.g., tactile guidance paths) suited to users with disabilities. “Public service facilities” refer to the everyday services needed within the unit, including small shops, laundry rooms, basic medical points, kiosks, snack bars, and small cultural venues (e.g., mini-theaters). Quiet sports facilities (e.g., table tennis, tennis, badminton, billiards) can be located within the unit to meet student needs without disrupting classes, while louder facilities (e.g., basketball courts, football fields) are better placed at unit edges, outside the unit, or shared among multiple units. Well-designed service systems increase convenience while also multiplying locations and opportunities for interaction.

In spatial terms, the molecular unit is typically planned around a comfortable walking radius, making walking the dominant mode of movement. A walk-oriented structure offers several benefits: it increases chances for communication and contact; it improves observation and readiness to participate in public outdoor activities; and it supports appreciation of campus landscapes, strengthening environmental recognition and community feeling. Road spaces can be designed to allow coexistence of pedestrians and limited vehicle movement, but to encourage outdoor use and spontaneous teacher–student encounters, it is recommended that parking be located approximately 100–200 meters away from teaching buildings or faculty apartment clusters. Moreover, the circulation network should be conceived not only as a transport channel but also as a dynamic interaction space, and design decisions should explicitly support this social function.

Diversified Apartment Typologies

Because students come from different backgrounds and face varying economic conditions, and because social time and interaction needs often change as students progress through grades, both private-space and public-space demands within molecular units are multifaceted. Therefore, housing within the campus community should provide apartment options suited to different groups and life patterns. A mixed portfolio can be formed in which hotel-style student apartments serve as a primary typology, complemented by short-corridor layouts and unit-based apartment forms, as conceptually shown in Fig. 5.

To implement community integration, a key task is establishing layered shared spaces and planning diverse interaction activities. Student apartment design should therefore incorporate a hierarchy of interaction spaces, including indoor facilities (e.g., small gyms, activity rooms, meeting rooms) and outdoor extensions (e.g., terraces, courtyards) to support vibrant extracurricular life. Research in social psychology suggests that similarity, proximity, and compensatory attraction influence the formation of student groups; while proximity effects may weaken with higher grades, similarity and compensatory attraction remain comparatively stable. Accordingly, providing diverse activity places within dormitories can stimulate engagement and create important gathering nodes.

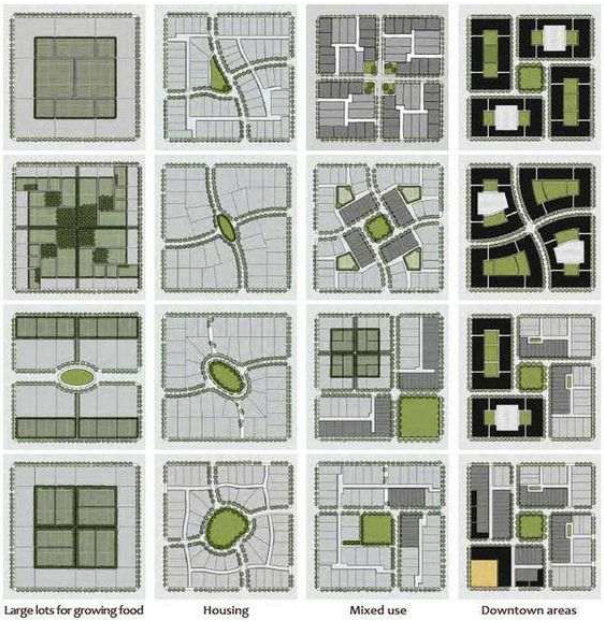

Figure 5: Representative student apartment typologies (schematic).

International examples also offer references for multi-level interaction-space design. For instance, some dormitory projects explicitly respond to differences in interests and user groups by providing differentiated recreational spaces; likewise, designs that embed a sequence of public environments within student housing can provide multiple settings for varied exchanges and activities.

Finally, supporting service facilities within apartments—such as laundry, hot-water access, and everyday retail—should be distributed and designed for practical usability. When such facilities are overly centralized and operate with limited or irregular availability, they become difficult to use and reduce everyday encounter opportunities. Surveys often show strong demand for convenient in-building laundry rooms. Moreover, because student clothing-care needs are diverse, a laundry space may benefit from additional equipment beyond washing machines, such as sinks, drying systems suited to local climate, ironing stations, and simple sorting/folding areas. These features not only improve convenience but can also become informal spaces for light work and interaction. Laundry rooms can be configured independently or combined with other utility rooms (e.g., hot-water bathing areas, water-boiler rooms, washrooms). Since hot water is frequently needed for drinking, hygiene, and other daily tasks, providing accessible hot-water facilities within dorm buildings is important, either through shared boiler rooms or through decentralized water heaters and supply lines. Small shops or vending machines located within dormitory buildings can further support everyday needs and reduce friction in student life.

SPATIOTEMPORAL DATA VISUALIZATION ON STUDENT CAMPUSES

Management of Spatiotemporal Data Repositories

This component provides database-query capabilities for a campus spatiotemporal distribution visualization platform. Users can retrieve required information by applying filters such as grade level, online duration, weekday, student ID, and related attributes. Query outputs are returned as a list within the interface, enabling fast inspection and selection. For example, by specifying the cohort of 2020 and selecting the time window

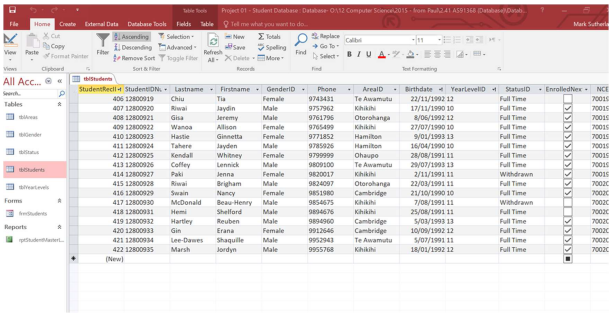

Figure 6: Spatiotemporal data management module (query and list-based results display).

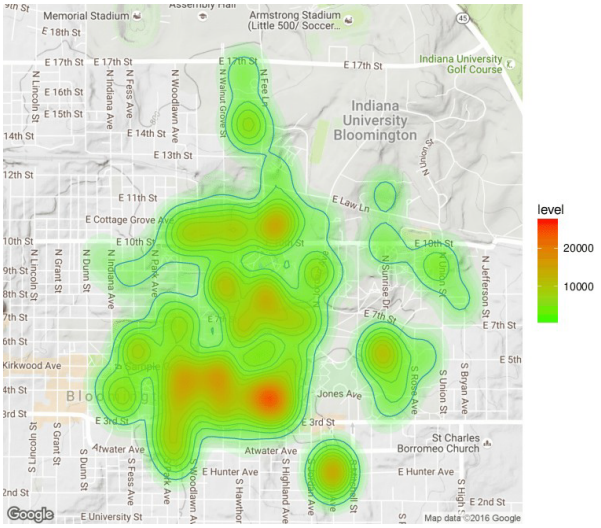

Figure 7: Dynamic heat-map visualization of student distribution over time.

11:00–12:00, the system can quickly produce the corresponding student distribution; the interface output is illustrated in Fig. 6.

Visualization of Spatiotemporal Dynamics

This module is the core of the system. Its primary function is to visualize the spatial distribution of campus students' Internet access on a map while simultaneously presenting associated mathematical summaries and statistical indicators. The map view supports multiple representations, including raw distribution points, dynamic heat maps, cloud-layer displays, and point-clustering (aggregation) maps. In implementation, Baidu Maps is used as the base map engine via its JavaScript API.

(1) Dynamic heat map. A Baidu heat-map layer is employed to display distribution intensity, allowing users to tune parameters such as transparency, color mapping, and influence radius. Color blocks on the map encode changes in crowd density and spatial shift patterns. As illustrated in Fig. 7, areas with the highest concentration are shown in red, and lighter colors indicate lower counts. To support temporal exploration, the system provides a time-slider function that visualizes changes in student spatiotemporal distribution across a full day. As shown in Fig. 7, the slider at the lower-right corner can be dragged to any specified time to display the campus distribution for that interval, in addition to playing an automatic 24-hour animation.

(2) Cloud dot-state ("pockmark") map. Fig. 8 shows a point-based distribution view built using the Baidu

Figure 8: Cloud-layer dot (“pockmark”) map for Internet reception points and WiFi coverage.

LBS cloud data-layer function. This view emphasizes Internet signal reception locations and WiFi coverage within campus buildings. The implementation idea is to generate dot patterns on a dedicated layer, overlay the dot map onto the base map using a custom-layer interface, and then use a hotspot interface to trigger text display when the cursor hovers over active points.

Statistical Chart Display

This module focuses on classifying spatiotemporal records and organizing student attributes into statistical visualizations. The interface supports mouse-based navigation to charts to view detailed values (Fig. 9), and it also allows exporting charts in multiple formats such as PDF, JPG, and PNG. Chart rendering is implemented via a lightweight pure-JavaScript visualization library that supports diverse chart types, including line (curve) charts, bar charts, pie charts, scatter plots, and composite graphics.

To reduce the chance that analysis is distorted by atypical behavior on any single day, the module aggregates a complete set of database records within a selected period, revealing how Internet-user counts vary across hours of the day and making temporal patterns easier to identify. For comparability, the values are normalized by proportional differences to account for variation in the population base across grades. Fig. 10 presents an example showing how the number of undergraduate Internet users changes over the same time-of-day interval across different grades.

Overall, the daily curves across grades exhibit highly similar fluctuation trends, suggesting temporal convergence in student activities. A closer reading of the curve indicates multiple peaks clustered around class transitions: approximately 30 minutes before classes begin and about 30 minutes before classes end. This implies that many students go online while waiting for class to start, and that attention may decline as class end approaches, which is reflected in a sharp rise in Internet use. These observations indicate that cultivating positive pre-class habits and improving classroom attractiveness remain important issues for university teaching and management.

Internet use also shows a clear grade-level gradient: the proportion of students online generally decreases as

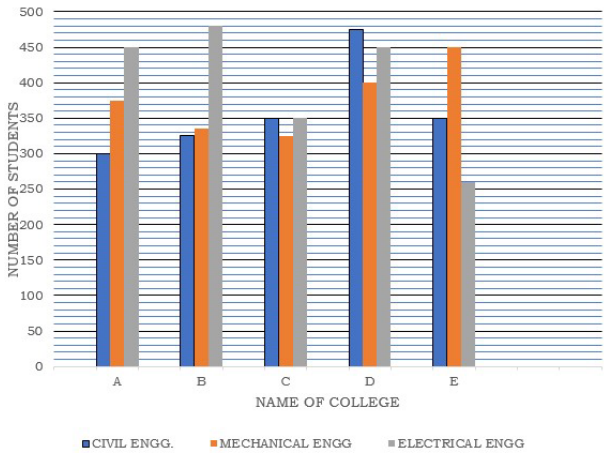

Figure 9: Statistical chart display module (interactive exploration and multi-format export).

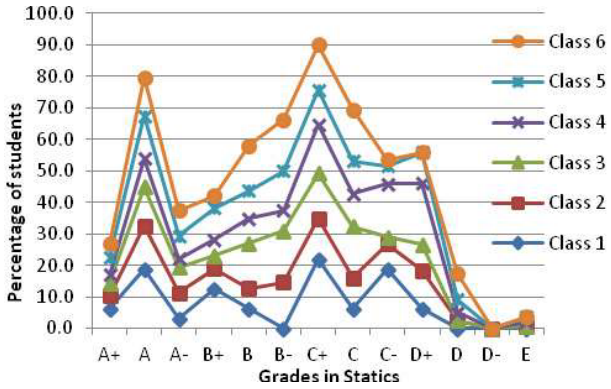

Figure 10: Variation in the number of Internet users across grades over a day.

grade level increases. Fig. 11 illustrates the overall decline in Internet-user counts from freshmen through seniors, with freshmen typically showing the highest frequency of access. A plausible explanation is that first-year students are newly entering university life, experience different academic pressures and routines than before, and are still becoming familiar with the campus environment, making online activity relatively more prominent. By later years, pressures related to examinations, postgraduate planning, and job searching may reduce or reshape online behavior, and senior-year access often appears both lower in level and less variable over time, indicating reduced online activity among graduating cohorts.

Across the week, the overall trend commonly rises and then falls. As shown in Fig. 12, Internet use increases during mid-week (e.g., Monday, Wednesday, and Thursday) and then declines toward Friday. This suggests that students are more likely to use the Internet on weekdays—for both study-related and leisure purposes—while weekend usage drops as students shift to offline activities such as shopping, socializing, or outings.

Moreover, the weekday–weekend contrast varies by grade. Weekend usage tends to decline more noticeably for higher grades, and the gap between weekdays and weekends is often larger for lower grades. For example, freshmen and sophomores may exhibit a stronger tendency to remain online on weekends, potentially because they are still adapting to campus life and have fewer established offline routines; higher-grade students, being more familiar with their environment, may spend weekends outside campus, engage in part-time work, or participate in more diverse offline activities. Consequently, weekend online counts are substantially lower than weekday values, and behavior becomes more heterogeneous.

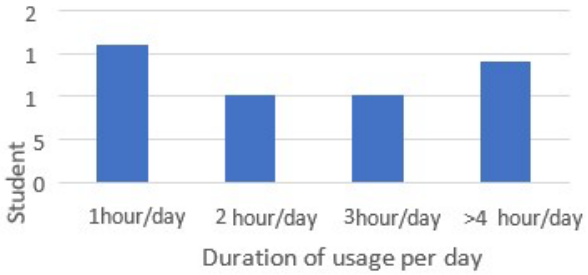

Figure 11: Weekly bar chart of Internet users across grades.

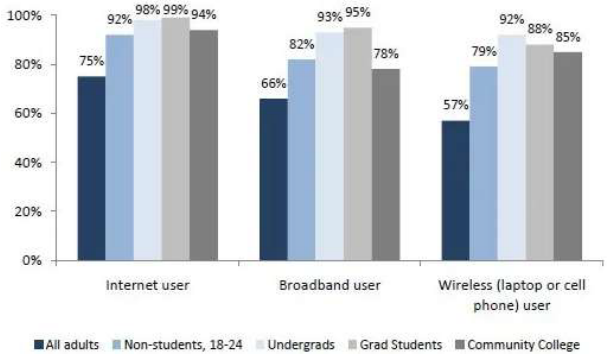

Figure 12: Inter-monthly graph of Internet users across grades (week-based parsing and weekday/weekend contrast).

In the implementation, daily Internet-login counts were computed for an April case study using undergraduate WiFi login records. The database converts raw timestamps into week-based categories (e.g., “Saturday 1” for the first Saturday in April), enabling analysis of both weekly regularities and weekday–weekend differences. The resulting statistics are shown in Fig. 12.

At the monthly scale, Internet-user counts for each grade show cyclical variation with broadly similar volatility, revealing a weekly periodic pattern in daily access. In addition, the per-week curve often exhibits a “rise then fall” tendency, indicating that undergraduate online behavior is relatively stable and consistent over time. Higher grades generally have fewer Internet users and smoother monthly curves. In Fig. 12, the graduating cohort presents the lowest counts and the least fluctuation, which aligns with the grade-level patterns observed at daily and weekly scales. This further suggests that senior students exhibit different activity choices due to stronger familiarity with their environment, different academic/task demands, and a wider set of offline options, leading to substantially lower online counts compared with lower-grade students.

Synthesizing observations across time scales, the temporal characteristics of student activity by grade can be summarized as follows:

1. Student activities across grades exhibit convergent and repeating temporal patterns. In particular, daily and weekly Internet-access distributions are similar among grades, with clear periodicity and consistency, reflecting the regularity of campus schedules.

2. Higher grades are associated with fewer daily Internet users and more stable behavior. As grade level increases, academic pressure, environmental familiarity, self-regulation, and the availability of independent activity choices also tend to increase, producing smoother monthly curves and a smaller difference between weekdays and weekends.

CONCLUSION

By analyzing how campus spatial organization relates to patterns of student community interaction, this study proposes a set of innovative strategies for campus space design and management. The results indicate that a spatial framework informed by the "molecular unit" concept can effectively promote teacher–student engagement while strengthening the social cohesion of campus life. In addition, improving the campus–city interaction mechanism supports more efficient resource utilization, expands opportunities for social practice, and broadens pathways for student learning and personal development. The mixed-living concept advanced in this work further challenges the conventional separation between faculty and students, invigorates daily campus life, and contributes to a higher-quality residential and learning environment. By emphasizing event-oriented spaces and cultivating a spirit of place, the study also highlights the importance of psychological belonging and cultural identification as key dimensions for enhancing overall campus environmental quality.

Overall, the findings provide solid theoretical support and practical guidance for spatial innovation in higher-education contexts, with a wide range of potential applications. Future research can further combine intelligent technologies with sustainable design principles to drive continuous improvement and more effective use of campus space throughout the ongoing digital transformation.

REFERENCES

[1] MOGHAYEDI, Alireza, et al. Assessing the influence of technological innovations and community-based facilities management on the safety and security of universities. A case study of an open campus. Facilities, 2024, 42.3/4: 223-244.

[2] ROY, Rumpa; EL MARSAFAWY, Hesham. University Campus Life and Activities Aligned with Students' Preferences towards Designing Competency Model Framework. International Journal of Learning, Teaching and Educational Research, 2023, 22.2: 188-206.

[3] Zhao-Bin Gao, Wei Qiu, Sin-Min Lee, Tai-Chieh Yang, Carl Xiaohang Sun. On Vertex Euclidean Deficiency of One-Point Union and One- Edge Union of Complete Graphs. Journal of Combinatorial Mathematics and Combinatorial Computing, Volume 121. 107-112. DOI: https://doi.org/10.61091/jcmcc121-11.

[4] YANPING, Zou; CHANPHONG, Somsak; JIRAROTEPHINYO, Nitwadee. The Effectiveness of" One-Stop" Student Community Education Management Model for Public Universities under Hubei Province. Journal of Modern Learning Development, 2024, 9.8: 591-611.

[5] KIM, Joo Young; KIM, Jung Hoon; SEO, Kyung Wook. The perception of urban regeneration by stakeholders: A case study of the student village design project in Korea. Buildings, 2023, 13.2: 516.

[6] KLIGYTE, Giedre, et al. A Partnership Outcome Spaces framework for purposeful student–staff partnerships. Teaching in Higher Education, 2023, 28.8: 1867-1885.

[7] Altay, A., & Mirici, İ. H. (2024).Efl Instructors' Implementations of 21st Century Skills in Their Classes. International Journal for Housing Science and Its Applications, 45(2), 37-46.

[8] Wu, Y. (2024). Exploration of the Integration and Application of the Modern New Chinese Style Interior Design. International Journal for Housing Science and Its Applications, 45(2), 28-36.

[9] DEEB-SOSSA, Natalia, et al. Qualities of safer and unsafe spaces at an emerging HSI: Community-based participatory research to center Latina/o/x undergraduates' voices in addressing campus issues. Journal of Latinos and Education, 2024, 23.1: 309-327.

[10] BOWDEN, Richard D., et al. College-Community Environmental Collaborations: Guidance for Successful Community-Based Projects and Research. In: Educating the Sustainability Leaders of the Future. Cham: Springer Nature Switzerland, 2023. p. 391-411.

[11] MA, Nazirman, et al. From Concept to Community Impact: the ABCD Model's Trailblazing Role in Community Service Programs. Revista de Gestão Social e Ambiental, 2024, 18.3: e06602-e06602.

[12] WITENSTEIN, Matthew A., et al. Conceptualizing a proposed model for re-orienting career centers for immigrant college students. Journal of Career Development, 2023, 50.3: 519-533.

[13] ROBLEDO YAMAMOTO, Fujiko, et al. "We are Researchers, but we are also Humans": Creating a Design Space for Managing Graduate Student Stress. ACM Transactions on Computer-Human Interaction, 2023, 30.5: 1-33.

[14] MARCHESONI, Joddy, et al. The student staffing advantage: Data science consulting service at NC State University libraries. Stat, 2024, 13.2: e702.

[15] AITHAL, P. S., et al. How Internal Quality Assurance System is Re-defined in Private Universities–A Case of Srinivas University, India. International Journal of Management, Technology and Social Sciences (IJMTS), 2023, 8.1: 234-248.

[16] KARAPIPERIS, Dimitrios, et al. A Probabilistic Approach to Modeling Students' Interactions in a Learning Management System for Facilitating Distance Learning. Information, 2023, 14.8: 440.

Patsy Healey, Patsy Healey, Newcastle University, King's Gate, Newcastle upon Tyne, NE17RU, UK; patsy.healey@newcastle.ac.uk

Manuscript Published; 12 August 2024.