A Study of the Effect of Third Spaces Incorporating Smart Material and Structures on Student and Faculty Engagement and Well-being: A Case Study from the Amity University Campus in Dubai

Al-Zahabi Salma[1], *Al-Kailani* Mohammed[2], *Noushad* Hanniya[1], *Kamar* Kamarunnisa[1]

[1]School of Engineering, Architecture and Interior Design, Amity University Dubai
[2]Life Space Interiors, Abu Dhabi, UAE

Abstract. The project evaluates how Amity University in Dubai's staff members and students' academic satisfaction, well-being, and engagement are affected by informal third spaces that use smart materials and structures. It aims to determine how these domains foster cooperation, diversity, sustainability, and creativity in an educational context. By examining the significance of adaptable technology and sustainable practices in enhancing the learning environment, the study seeks to offer evidence-based insights about how well third spaces foster academic engagement and well-being. In the end, the findings are meant to direct the creation of future learning environments that prioritize user-centric strategies.

The main technique used to gather data for the quantitative study design was a structured survey questionnaire. The survey's target audience consisted of students and faculty members, and it gathered opinions on informal third spaces from four angles: inclusivity, sustainability, smart materials, engagement, and technology. 110 respondents' data was collected via an online distribution technique, guaranteeing anonymity and according to ethical research guidelines. SPSS software was used for statistical analysis to evaluate the correlations between the key variables.

This research offers important insights into the design of educational environments that are user-centric, environmentally friendly, technologically modern, and ready to adjust to the changing needs of academic environmental settings by fusing theoretical advances with real-world implementations.

1 Introduction

In recent years, informal third space design in educational institutions has drawn a lot of attention due to its ability to improve wellbeing, encourage collaboration, and increase

student engagement. Collaboration spaces, cafes, and lounges are a few examples of significant additions to formal educational settings, where meaningful and spontaneous exchanges occur [1]. By striking a balance between social and academic expectations, these areas are crucial to fostering inclusive and vibrant university experiences.

There are innovative possibilities to rebuild these areas with the recent developments in smart materials and adaptable technologies. By allowing structures to adapt dynamically to shifting human demands and environmental conditions, these advances improve user comfort and energy efficiency [2]. The focus on informal third places on university campuses is a result of their capacity to address critical challenges in higher education, particularly encouraging a sense of belonging, increasing productivity, and accommodating a range of learning styles. This study investigates how innovative and inclusive third spaces can be developed through thoughtful design and technology integration using the Amity University campus in Dubai as a case study.

Third spaces are reimagined in this study as flexible, sustainable, and human-centered settings that surpass their conventional function as supplementary zones and become dynamic spaces that instantly adjust to the demands of users. These settings encourage collaboration, well-being, and environmental awareness. The study investigates users' willingness to interact with areas that use adaptive design principles and smart materials to get beyond existing functional limitations. The study intends to address environmental concerns and promote innovative experiences in learning through applying responsive technology to improve user comfort, reduce energy usage, and ensure inclusiveness. Phase-changing materials, for example, can control temperature, which lowers the cost of heating and cooling [3].

By evaluating the current informal spaces at Amity University Dubai, the main goal of this study is to bridge the gap between the theoretical advancements in smart materials and their practical applications in campus design. The aim of this study is to assess how these spaces promote student engagement and wellbeing, explore how incorporating smart materials affects sustainability and functionality, and offer practical suggestions for future designs that place a priority on environmental responsibility, inclusivity, and adaptability.

2 Literature Review

Higher education is seeing a rise in the use of Informal Learning Spaces (ILS), which are crucial for improving student involvement and experiences [4]. Third spaces in higher education emphasize interdisciplinary interaction and knowledge sharing while supporting a variety of objectives, including educational progress, student success, and public participation [5]. Libraries, student cafeterias, and other socially focused locations have historically hosted these kinds of events due to the communal character of recreation in higher education. These areas are frequently called Informal Learning Landscapes (ILS) [6].

Therapeutic sensory gardens are used as third spaces by some institutions, emphasizing their beneficial effects on students' quality of life and general well-being. Engaging with nature in these spaces fosters self-care, occupational balance, and improved mental health [7]. In design colleges such as Ahmedabad University and the Centre for Environment Planning & Technology, both formal and informal spaces foster collaboration, creativity, and community engagement. Elements like user needs, interaction-isolation balance, transparency, and nature contact are carefully analyzed [8]. Similarly, tertiary education institutions in Malaysia benefit from co-working spaces as informal learning environments, enhancing student interactions, well-being, productivity, and knowledge sharing [9].

Key design considerations for (ILS) include physical features, visual appearance, spatial dimensions, circulation flow, ergonomics, furnishings, lighting, colors, finishes, acoustics, HVAC systems, visual communication tools, social and cultural spaces, and accessories [10].

Research on spatial design elements identified six key characteristics—comfort, flexibility, functionality, spatial hierarchy, openness, and support facilities—that influence student use of these spaces [11]

A study at Mykolas Romeris University (MRU) highlighted the role of (ILS)as catalysts for student engagement, well-being, and campus satisfaction. These areas encourage digitalization, inclusion, and accessibility while strengthening interpersonal relationships and a sense of community. The study found that increased accessibility and availability of these areas greatly improves student wellbeing, university belonging, and general campus satisfaction [12].

These conclusions are corroborated by a 2003 study that compared workstations with and without natural daylight access and found that employees' memory recall, mental function, and general health all improved [13]. In addition to fostering community development and collaboration, a focus on openness, transparency, and adaptation in spatial design can offer focused study areas and privacy when required [14].

Recycled materials and modular construction promote sustainable campus architecture while improving educational experience for students. According to surveys, students appreciate modular elements that may be customized to create flexible learning environments that can accommodate varying group sizes and methods of teaching [15]. The Hong Kong Polytechnic University improves learning environments with creative designs that include ambient lighting, comfortable temperature modifications, and bright colors to inspire learning. Flexible group conversations are made possible with mobility seats and modular tables, which encourage active learning. In line with students' changing learning demands, these designs promote social engagement, physical activity, teamwork, and interaction [16]. Additionally, modular construction offers significant advantages, including shorter construction times, controlled production environments, reduced labor costs, and factory-standard quality controls [17]

Smart materials enable dynamic learning environments that adapt to diverse educational needs, fostering student interaction and engagement [18]. A digital wall proved to be a powerful tool for participants to share ideas and refine problem-solving methods [19]. Adaptive lighting reduces stress and conflict by adjusting to a person's emotional state. In shared spaces, dynamic lighting adjustments accommodate diverse user needs, creating a more comfortable and conducive environment for interaction and learning [20].

A green campus signifies a shift toward sustainability in educational institutions. It promotes eco-friendly practices that positively impact teaching and learning [21]. Sustainable materials and technologies, such as phase-change materials and self-healing concrete, enhance the performance and functionality of smart buildings [22]. Integrating biophilic design with sustainable development creates a strong model for evolving creative university campuses [23].

3 Study Objectives

Emerging innovations in architecture and interior design play an important role in creating adaptive, interactive, and sustainable environments. In informal learning spaces. This section expands on key objectives related to engagement, smart adaptability, and sustainability.

3.1 To evaluate the infusion of informal third spaces on enhancing users engagement, well-being and collaboration

This objective will be discussed through the role of the ILS through the understanding of the users' willingness to engage interactive, ergonomic and sensory responsive elements into the teaching-learning process, in addition to the ILS potential to provide

collaborative work environment.

The practical implementations of innovations in ILS can me represented by Photochromatic walls that change color and light intensity to be used as white boards adapting to different lighting, this method is used at MIT Media Lab utilizing interactive sensitive tables for dynamic group discussions [24]. Acoustic and lighting smart controls are used in the form of sound-absorbing smart panels to reduce noise, adjustable LED lighting to in harmony with the Circadian Rhythms, as an example of implementation, Harvard iLab uses smart lighting systems that adjusts its intensity based on activity levels in learning spaces [25]. Furthermore, smart biophilic material used in Cornell University in the form of hydrogel moisture regulation to improve the air quality [26]

3.2 To identify the impact of integrating smart material on creating an adaptive educational environment

The reason for looking into the impact of smart material in ILS is because of its ability to provide adaptive learning environment based on the users' needs through flexibility and configurability, advanced technologies and focus on comfort optimization.

Smart material implementation can be seen in Shape-Memory Furniture and partitions where desks and chairs adjust their shape to provide optimum comfort as in ETH Zurich integrates shape-memory tables that adjust height based on user preference [27]. Electrochromic glass provides privacy according to users' requirements and controlling glare, as in Middle Tennessee State University employs electrochromic glass[28]. Energy harvesting flooring is used in Edge, Amsterdam (in collaboration with University of Amsterdam)[29]

3.3 To understand the interaction of innovation and sustainability in learning space planning with focus on the integration of sustainable strategies and technology

The purpose of this objective is to understand the users' attitude towards the implementation of sustainable interior design elements within the educational institute to reduce carbon footprint, resource consumption and enhance long-term adaptability.

Thermochromic and Phase Changing Materials (PCMs) used in walls and other interior surfaces to absorb or release heat as a passive technique without using energy consuming devices [30]. Titanium dioxide-coated walls that can break down dirt and bacteria making the interior spaces surface self -cleaning [31]. Microfiber-based smart curtains used to provide Energy-Efficient Ventilation with Smart Textiles through regulation of indoor airflow based on external temperature [32].

4 Methodology

A quantitative research method was employed to explore student and faculty perceptions of informal third spaces at Amity University, focusing on their impact on academic engagement, collaboration, well-being, and sustainability. Quantitative research is effective for identifying patterns, relationships, and trends across large groups of respondents [33]. By using a structured survey, participants' attitudes and experiences regarding the design and function of these spaces were systematically gathered.

The three pillars of the metrics taken into consideration by this study—environmental, economic, and social benefits strengthening the discussion on how different factors were taken into consideration. These metrics are detailed in the following table:

Metric	Description	Application in Third Spaces
Environmental Sustainability Metrics		
Energy Savings	Lower energy consumption due to smart materials.	Electrochromic glass reduces HVAC usage.
Carbon Footprint Reduction	Reduce CO_2 emissions due to energy-efficient materials.	Kinetic flooring in study spaces generates electricity from footsteps.
Material Life Cycle Analysis (LCA)	Assess the sustainability of material sourcing, utilization, and disposal.	Phase-change materials (PCMs) store and release heat.
Resources Savings	Reduction in water usage due to smart surfaces.	Self-cleaning walls eliminate water-based cleaning.
Economic Sustainability Metrics		
Cost Savings	Reduction in operational expenses due to smart materials.	Smart LED lighting reduces electricity costs.
Return on Investment	Ratio of cost savings to initial investment over time.	Energy-efficient smart glass lowers long-term costs.
Maintenance Reduction	Decrease in cleaning and repair costs.	Self-healing surfaces extend material lifespan.
Social Sustainability Metrics		
User Satisfaction Score	Surveys measuring student experience in smart learning spaces.	Smart furniture with sensors adjusts for user comfort.
Cognitive Performance	Improvement in student focus and learning outcomes.	Circadian lighting adjusts to optimize study efficiency.
Collaboration Index	Measurement of student interactions in learning spaces.	Interactive whiteboard surfaces enhance teamwork.

Table. 1. Study Metrics

A systematic survey questionnaire aimed at assessing participant agreement on a range of topics related to informal learning spaces, such as the environment, innovative materials, and sustainability on university campuses, served as the primary instrument to collect data. A five-point Likert scale, a commonly used instrument for capturing subjective perceptions, was used for each question [34]. This method facilitated the evaluation and interpretation of statistics as well as the measuring of attitudes [35].

There were four parts to the survey:

1. Informal Third Spaces: This section's questions examined how much informal spaces like lounges, cafes, and libraries promote engagement, collaboration, and community belonging.
2. Smart Materials and Adaptive Environments: The aim of this section is to evaluate views regarding the effects of technologically enhanced environments impacting learning experiences.
3. Sustainability in Educational Spaces: Questions explored the role of sustainable materials and biophilic design in promoting environmental responsibility and academic satisfaction.
4. General comments: information from all sections is collected to gain an overview on whether the present learning spaces align with students' expectations around innovation, engagement and sustainability

Sampling Strategy followed a purposive sampling approach, targeting students and faculty who actively use informal third spaces. The rationale behind this strategy was to collect experience-based responses rather than generalized opinions from the public. The inclusion Criteria considered the participants who have used the current ILSs in Amity

University for academic or social purposes, while Exclusion Criteria removed those with no prior interaction with informal learning spaces.

The research adopted a purposive sampling approach, specifically targeting students and faculty at Amity University who are actively engaged in informal third spaces. This strategy enabled the collection of relevant information [36]. A sample size of around 230 participants resulted in 114 respondents was deemed satisfactory for achieving statistical power, considering the circumstantial limitations at the time of the study. Data was collected over a two-week period through the online distribution of the questionnaire. Figure 1 shows the respondents' number and distribution.

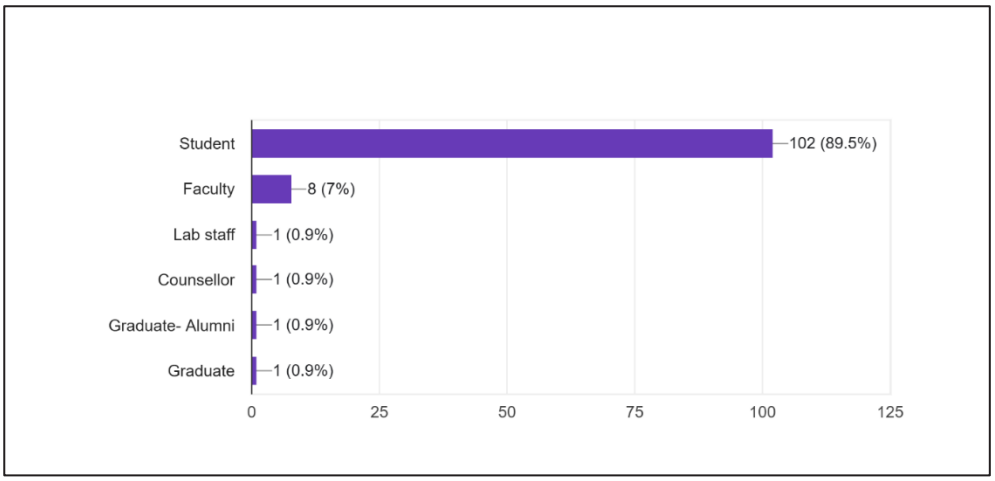

Fig. 1. Respondent Distribution Chart

Ethical research guidelines were adhered to, with participants informed of the study's purpose [37]. The use of an online survey ensured participant anonymity and ease of access, contributing to higher response rates [38].

The quantitative data collected was analyzed using statistical tools. Descriptive statistics summarized central tendencies and variability in survey items, providing an overview of respondents' attitudes [39]. Inferential techniques, such as correlation analysis and regression models, were employed to examine relationships among key variables, including the perceived impact of informal third spaces on academic engagement and well-being. Statistical analysis was conducted using SPSS software.

The study was conducted in accordance with the ethical principles of the British Psychological Society (2014), ensuring that participation was voluntary, consent was informed, and confidentiality was maintained. Ethical clearance was obtained from Amity University.

While the findings offer valuable insights into the role of informal third spaces, several limitations must be acknowledged. The sample size may fall below general survey guidelines due to the short timeframe for the study. The targeted sampling method may limit the generalizability of findings beyond Amity University. Furthermore, data obtained through self-reports is subject to social desirability bias [40].

5 Data Analysis

Figure 2 shows the responses distribution, and the trend noticed towards the subject of this study, the main results are summarized as follows:

- **Engagement in Informal Learning Spaces:**

As Figure 2 shows, most respondents rated the third space environment as supportive of collaboration, indicating a strong belief in its effectiveness for fostering interaction.

- **Impact on Well-being and Academic Satisfaction:**

About 45% of respondents believed that informal third spaces positively influence their well-being.

- **Connection to the University Community:**

Nearly 48% of respondents felt connected to the campus community through informal learning spaces, underscoring the role of these spaces in fostering a sense of belonging.

- **Inclusivity of Informal Learning Spaces:**

Almost half of the respondents indicated that these spaces are only somewhat inclusive, highlighting a need for improvements to better accommodate diverse users.

- **Effectiveness of Smart Materials and Adaptive Technologies:**

80% of participants agreed or strongly agreed that smart materials and adaptive technologies improve productivity, promote well-being through enhanced comfort and health, and foster collaboration. However, 20% were either neutral or disagreed, possibly perceiving advanced technologies as reducing the coziness of relaxing spaces—a topic worth exploring in future research.

- **Sustainability:**

Half of the participants rated the adoption of sustainability practices as "Extremely Important," while about 60% indicated that sustainability significantly enhances the academic experience. Similarly, 60% prioritized innovation and sustainability in third-space design.

- **Inferential Statistics:**

Correlation and regression analyses were conducted to explore relationships between key variables. The findings revealed a strong correlation ($r > 0.7$) between the effectiveness of smart materials and productivity, indicating their importance in enhancing user satisfaction. Regression analysis further showed a significant positive impact ($p < 0.05$) of informal space availability on users' educational experiences and well-being.

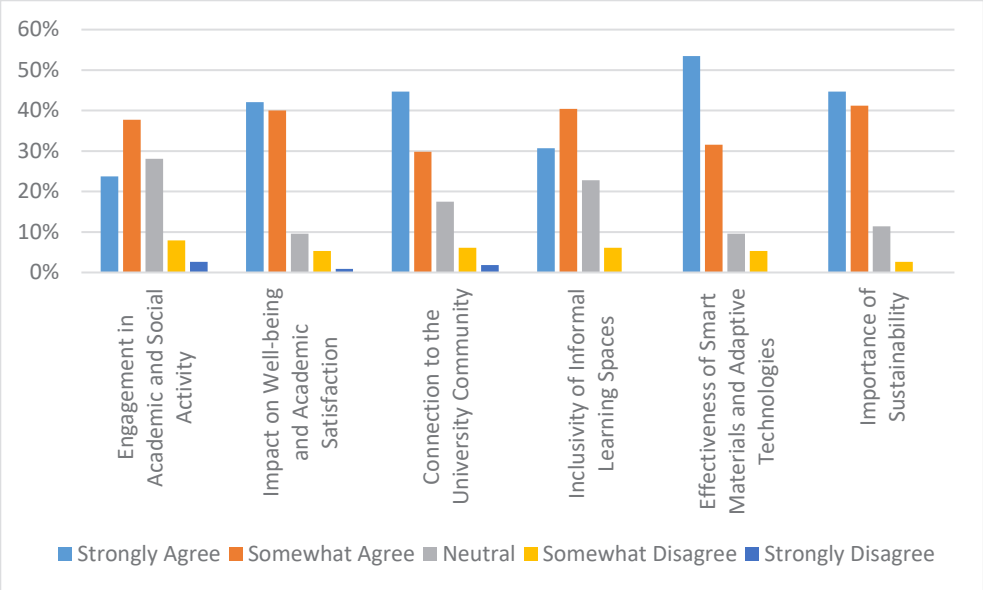

Fig. 2. Responses Distribution

6 Discussion

The result of this study aligns with the literature highlighting the role of Third Spaces as ILSs in improving engagement, collaboration and well-being of the users. Comparison to the literature this study showed the following:

- Engagement and Collaboration: the study found 80% of respondents acknowledged the positive impact of smart material and adaptive technology, which aligns with Wu et al. (2021) who found that ILS play an important role to encourage students' interaction and knowledge sharing [11]. Mačiulienė et al. (2024) also concluded that third spaces contribute significantly to campus community belonging [12].
- Effect of Smart Technologies on Adaptive Learning Environments: the suggested use of adaptive technologies and material aligns with the use of similar technologies in other educational institutes.
- Sustainability Considerations: the findings of this study confirmed the importance of sustainable strategies, according to 60% of respondents which is in line with Smith (2019) [3] who highlighted the role of sustainable strategies in reducing environmental impact and improving educational experience

7 Study Constraints and Future Research Directions

The study encountered several constraints like the limited knowledge of participants of smart material and sustainable interior design strategies which might have reduced the number of survey respondents, lack of similar places in Dubai that utilizes such strategies might also has lowered the participants willing to respond.

Future research in this area might focus on specific case studies that adopt a virtual design scenario incorporating computer simulations to measure sustainability measures efficacy. Research interested in this area of knowledge can involve education specialists to discuss educational and engagement aspects in further detail.

8 Conclusion

This study provided insights into the role of informal third spaces incorporating smart materials and adaptive technologies to enhance student and faculty performance, engagement, well-being, and academic progression within an educational institution. The case study focused on the Amity University Dubai campus, demonstrating how these spaces are perceived as fostering collaboration, inclusivity, and alignment with sustainable development goals to create future-ready educational settings.

The results indicated a positive correlation between the integration of advanced materials and increased productivity and well-being. Additionally, areas for improvement were noted, such as wider adoption of sustainable practices and inclusion. The study also demonstrated how biophilic design, modular construction, and dynamic adaptable settings may be used to create multipurpose rooms that accommodate a range of learning needs.

Based on survey findings, 80% of participants agreed or strongly agreed that productivity and well-being are enhanced by smart materials and adaptable technologies. About 60% of respondents emphasized the significance of sustainability in enhancing academic satisfaction, and nearly half identified inclusion as a major area for improvement. 48% of participants reported an improved sense of campus community belonging, and statistical analysis verified a positive correlation between third spaces and user satisfaction ($p < 0.05$).

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