Focus Group Insights into Student Experiences and Real-Time Data Visualization Expectations to Enhance Campus Life

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Abstract. This study investigates the potential benefits of a smartphone application designed to enhance student experiences at IADE, Universidade Europeia (Portugal) by providing real-time information on campus space occupancy, availability, and indoor environmental quality. Focus group sessions with 33 s-year BSc Design students highlighted issues like overcrowded areas, insufficient dedicated study spaces, and unclear classroom usage policies. Students primarily use campus facilities for studying and collaborating, and they appreciated the proposed app's features, including real-time data on occupancy and indoor environmental quality, which would improve their search for suitable study environments. Suggested additional features included desk and equipment reservation systems, integration of lab and studio waiting lists, and event notifications. While the app is expected to positively impact students who already use campus facilities, it may not attract those who prefer studying off-campus. Although the study provided useful insights, it is important to consider that it is limited by the lack of sample diversity: all participants were enrolled in the same course and year, and the nature of the course may also induce a bias. Pre-existing dynamics between participants also may have affected the length and depth of discourse during the sessions. Further research should include a broader sample of both students and faculty.

Keywords: Student Experience · Smart Campus · Internet of Things

1 Introduction

Finding suitable spaces on university campuses for studying course materials, working on assignments and classwork, collaborating on group projects, interacting and socializing with peers, and other activities outside of class can be time-consuming and frustrating,

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especially when specific needs must be met. A proposed tech-based solution for IADE, Universidade Europeia (UE) (Portugal) involves a smartphone application that provides real-time data on campus spaces via sensors, aiming to alleviate these difficulties and enhance the student experience.

The use of networked sensors and Internet of Things (IoT) devices for data collection and processing not only promotes a smart environment but also opens up new possibilities for better resource management and decision-making. Data collected through continuous monitoring reveals detailed insights and patterns in the use of campus facilities; this facilitates data-driven decisions based on current and accurate information, enhancing the effectiveness of the university's strategic and operation processes, and enabling the optimised use of campus resources, including space and energy [1–3].

Additionally, the use of such technologies fosters adaptive and responsive campus environments, as collected data on lighting, temperature, air quality, and other Indoor Environment Quality (IEQ) factors can be applied to control and adjust the settings of campus infrastructure dynamically, optimising the use of campus resources, and optimising the comfort of students and faculty [4]. For instance, dynamic adjustment to the Heating Ventilation and Air Conditioning (HVAC) system based on occupancy rates and indoor environmental conditions, rather than relying on fixed settings and schedules, not only optimises energy consumption, reducing campus operation costs but also improves indoor air quality, consequently improving the comfort and health of students and faculty [5].

Dynamically adapting campus infrastructure is particularly relevant as thermal comfort (temperature, air quality), lighting, and acoustics are key IEQ factors impacting learning, productivity [6, 7], satisfaction, comfort [8], health, and well-being in university spaces [9].

While the perception of productivity is strongly correlated with environmental comfort, it is important to note that compliance with the ranges and criteria for IEQ factors may not directly result in subjective comfort (for instance, compliance with the recommended range for temperature may not effectively result in thermal comfort) [4].

While implementing IoT technologies on university campuses raises technological, ethical, data privacy, and security issues and concerns, as well as representing a significant investment in infrastructure [2] there is a rich potential for IoT technologies to transform educational environments, optimising learning, and working conditions through targeted data analysis and responsive infrastructure adjustments [10].

At this early stage of the project, some aspects of the digital product have been outlined through the analysis of similar solutions in the market (such as Mapiq [11], Teem (now, Eptura) [12], Robin [13], Envoy [14], and Waitz [15]) and observational research on campus, particularly: (1) relevant data to be presented: room occupancy, room availability and scheduling, room type, air quality, HVAC and ventilation, equipment available, room temperature, lighting level and type, and noise level; (2) functions and secondary features: space search according to filters, favourite spaces and respective notifications, campus events notifications and signup, space reservation (individual seat or desk for students and room reservations for faculty).

Observational research, in particular, allowed us to have an initial understanding of possible pain points in the students' journey and experience, particularly the difficulty of

finding available seats due to overcrowding of two particular common areas (cafeteria and lounge), the inexistence of dedicated study rooms, inadequate environmental conditions (particularly overheating in the classrooms and lack of ventilation); additionally, usually, students seemed not to utilise other spaces on campus other than the cafeteria, lounge, and library, as few students used empty and available classrooms.

The main objective of the ongoing project is to enhance the quality of the on-campus experience for both faculty and students. This will be achieved by streamlining the process of finding campus spaces, addressing related issues, and leveraging data to enhance the surrounding environment. Ultimately, the goal is to encourage faculty and students to make the most of the campus resources. Focus group sessions with IADE, UE students were therefore held at the project's inception to gain insight into the current student experience and pinpoint pertinent pain points. Additionally, the idea for the digital solution was refined by determining which data and information are most pertinent and what additional features and functions could potentially alleviate the students' concerns, guaranteeing user-centric design choices and the development process of the solution. In this sense, this paper reports the results of the focus group sessions which aimed to understand the students' experience.

2 Methodology

2.1 Design of the Study

This study followed a qualitative approach, assessing both the students' current experience with campus facilities and their feedback and expectations on a proposed digital product, through focus group sessions.

2.2 Participants

This study was conducted with 33 participants, distributed into five focus groups, each with 6 to 7 participants. All participants were 2nd year students of the bachelor's degree in design at IADE, UE. Of the 33 participants, 24 were female and 9 were male, and their ages ranged from 19 to 24 ($\mu \approx 20.24$; $\sigma \approx 1.46$).

2.3 Procedure

The conducted sessions took place in campus classrooms, during the Interaction Design classes, and followed three stages: (1) introduction and sample characterization; (2) evaluation of the current experience; (3) expectations and feedback on the digital solution. The average duration of each session was 22.3 min ($\sigma \approx 4.66$).

During the first stage, each focus group was briefed on the project, the goal of the study, and the format and protocol of the first phase. Details about their age, gender, course of study at the moment, and number of semesters as an IADE, UE student were collected.

The second stage introduced questions and themes that would encourage participants to share their current experience at campus facilities, which would allow us to map user

journeys, and identify common pain points, unmet needs, and expectations – particularly, those derived from issues in the management of campus spaces – and understand how heavily these issues impacted the experience of students at the campus. As such, the following themes, and respective questions, were introduced:

1. *Free time, i.e., time during which students are not actively in classes.*
   a. How frequently, and for how long, do they spend their free time on campus?
   b. What are their motivators or activities: extracurricular activities, class work, and projects, exam preparation, particular spaces (laboratories, studios), particular equipment or data, to socialise with friends and colleagues?
   c. In general, do they spend it by themselves or with others?
   d. Are there any particular places other than the IADE, UE campus they rather use to perform such activities? If yes, which are they, and why?
2. *Walkthrough of their routines, i.e. their habits when carrying out activities on their free time, on campus.*
   a. Are there particular periods or times in the day they tend to utilise campus facilities?
   b. Do they have customary spaces they initially look for? Why are these spaces preferred?
   c. What is, if existing, their search process when their preferred spaces are unavailable, occupied, or do not meet their expectations? How easy is this process?
3. *Challenges that arise:*
   a. In their search process: understand which are the main issues and challenges in finding campus spaces to carry out their activities, and whether this point may lead students to abandon the facilities and choose other places or campuses.
   b. In campus spaces: understand reoccurring issues with campus facilities that do not meet students' needs and expectations, and may deter them from utilising each campus space (such as classrooms, study rooms, library, amongst others).

The third stage concerns the proposed digital solution, a smartphone application that would allow students and faculty to view real-time data of each campus space: availability and scheduling, occupancy, and indoor environmental quality factors. The purpose of this stage was threefold: (1) to understand the impact of the solution on their current experience, to assess whether or not this solution would address their pain points; (2) to validate findings, particularly regarding the types of data to be collected from campus spaces. Such data would allow us to define which information is most valued by students in their search for campus spaces; (3) to foster student-student and researcher-student collaboration in the design process, allowing students to shape the type, content, and structure of the solution. As such, the following themes, and respective questions, were introduced:

1. *Expectations on data, i.e., space information collected through the sensors and made available in real-time.*
   a. When looking for a place to conduct activities in their free time, what are the characteristics and qualities that influence their choice? What data would aid them in their search process?
   b. Is there a preferred data visualisation for this data – graphs, tables, text, iconography? Should quantitative data be provided in qualitative form, or both (e.g., the temperature in Celsius versus expressions such as "feels warm").

   c. Are there concerns related to the installation of sensors in campus spaces, e.g., privacy concerns?
2. *Discussing the digital product.*
   a. Are there other appropriate, or preferred, mediums for this solution? Does it "make sense" to integrate it with another university mobile application, for practicality, or be a standalone product, to retain purpose?
   b. What other features or functions could this product encompass, besides providing real-time information on campus spaces, to improve its value and impact on students' experiences?
3. *Impact and value of the digital product.*
   a. What would the impact be on their current experience with campus facilities – positive, negative, or indifferent? Understand in what ways it would change their current journey, or in what ways it may be failing to address their challenges and issues.
   b. In their opinion, what would the impact be on others' experiences? This is particularly applied to students whose personal journey may not be affected by the solution, for external reasons (e.g. working students).

Since focus group discussions were not strictly structured, some themes were discussed earlier than anticipated or within other stages as the discussion naturally developed. As a result, the defined progression of stages and themes, as well as its contents, were only indicative. Furthermore, and for the same reason, groups differed in the depth to which they discussed each of the introduced themes and questions.

3 Results

The five sessions were audio recorded, transcribed, and the resulting texts were then analysed through:

1. Thematic analysis, in which, for each transcribed session, particular quotes were selected and attributed a code based on themes they addressed. The identified themes, and respective insights, were then refined;
2. Comparative analysis, in which the insights about the identified themes were directly compared amongst the transcribed sessions, to understand how themes varied across the groups. The resulting insights from this analysis are categorised into three subsections and structured according to the main discussion points.

3.1 Current Experience

The following insights pertain to the second stage of the focus group sessions, in which we established the current student experience and main pain points.

Main Motivators. All students reported classwork, specifically group projects, as the main motivator for spending their free time on campus, where they would arrive a couple of hours earlier than their classes, or remain on campus a few hours after, to get together with classmates and work together, particularly at work-intensive periods, such as the end of the semester. Contrastingly, when by themselves, such as when studying

or preparing for exams, students would rather stay at home. The second most common motivator was the access to resources necessary for classwork, often only available on campus, such as particular equipment and machinery (e.g., computers with license-required modelling software, physical modelling materials, woodworking tools, and 3D printers) and respective access to the library and laboratories, such as the 3D lab, media lab, or digital lab. Students also mentioned they remain on campus for practical reasons, such as gaps in their schedule of a couple of hours, during which leaving campus and returning would be impractical; similarly, students who live further from campus found it practical to arrive earlier due to transportation scheduling, to avoid traffic, or to carpool, and wait for their classes on campus. Finally, only a reduced number of students mentioned extracurricular academic activities (e.g., tuna (music group) practice, workshops or competitive events, and student organisations) as a motivator or reason for spending more time on campus.

Preferred Spaces. At IADE, UE, students reported the cafeteria/bar and lounge areas (see Fig. 1) as the primary places to spend their time outside of classes, mainly to work together on class projects. However, these were also a primary source of dissatisfaction for students, as is discussed in the following sub-section. While the library was also frequently mentioned, it was not the preferred location as they were not able to speak and discuss freely, a crucial component of working on group projects. Thus, the library was primarily used for computer access and, secondarily, for individual study and consulting available books.

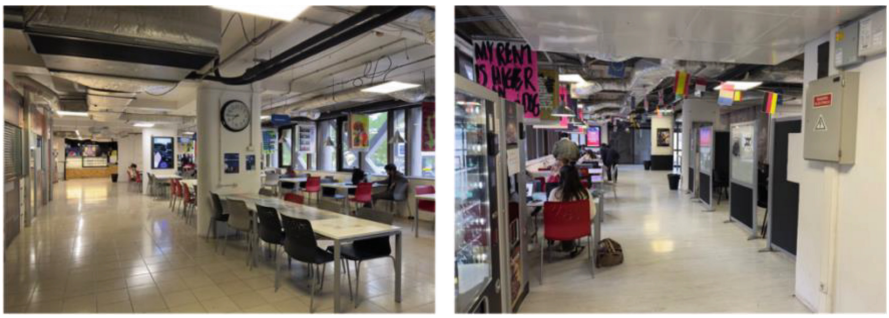

Fig. 1. Cafeteria/bar (left) and lounge (right) areas.

Reoccurring Issues. The primary facilities issue identified, from which multiple pain points stem, is the lack of existing spaces for students to perform their activities, i.e., studying and performing classwork, eating, and/or socialising, by themselves or in a group. Stemming, or associated with this primary issue, are the following pain points: (1) the process of finding a place to perform their activities is challenging – with mainly the library, cafeteria, and lounge spaces available, and the library not considered available for studying and working in groups (which is the primary driver for spending time on campus), the cafeteria and lounge areas quickly become overcrowded. As a result, (a) very frequently, students are unable to find available seats to work ("There's no space to eat, let alone work (…)"). Being unable to find a space to perform their activities

was directly mentioned as the cause of why students are not able to spend more time on campus and often abandon the premises to go to other places instead, e.g., other universities, coffee shops, home, or online, through video call and messaging/chat, which was described as very impractical for the types of projects they are usually assigned. In one of the focus group sessions, students mentioned that one of them would go to campus first and communicate to others whether there were seats available or not; (b) the coexistence of a meal area and a study area makes it hard for students to find a place to have their meals, as a lot of it becomes occupied by students who are studying and working; (c) the cafeteria and lounge areas become excessively noisy and/or dirty, which often renders the space unusable for particular activities; (2) students are often forced to find unconventional spaces to perform their activities, which includes the parking garage, seating down on the floors of the building, in the benches along the hallways, and outside, in the entrance of the building, which are not optimal or comfortable places for students to study, work, and/or socialise.

These pain points were also aggravated by the (3) unclear policy of classroom use; as there are no dedicated study rooms besides the library space, the use of empty, available classrooms was mentioned and discussed in all focus groups albeit with conflicting experiences. A few students mentioned that they were not allowed to use these classrooms, as it was indicated to them that they were restricted; others mentioned they were allowed to utilise these classrooms providing they made a reservation at the front desk for a specific time slot. However, the most commonly reported experience was students using empty, open classrooms and remaining there until they were asked to leave; as no information on room schedule or availability is currently provided, this process of searching and choosing a classroom would be either at random, causing students to be uncertain about how long they would be able to utilise the space, or students would use the rooms they would later have class in (i.e., arriving thirty minutes before class and using the classroom, if unlocked and available). The inconsistent experiences and the pain points in utilising available classrooms have discouraged students from this option and caused them to continue focusing on the previously mentioned common areas.

Other pain points concern the (4) quality of campus spaces, and its negative impact on their experience, particularly (a) noise, both overly noisy areas, as a product of overcrowding, which creates a poor environment to study and do classwork in, and the noise restrictions in the library, which, in turn, cause students to work in the common areas; (b) reduced number of power outlets, causing students to be frequently uncertain of whether they will be able to power their devices on campus, and, at times, unable to work; (c) lack of comfortable and inviting furniture in the student lounge; (d) air quality, in particular, the HVAC system not responding correctly to the temperature in the classrooms, as it operates on fixed settings for the season/for the month. Additionally, these fixed settings may also cause a lack of ventilation, where students describe the environments as often becoming stuffy and gaining odours, particularly in sun-facing rooms. Three focus groups discussed particularly the negative impact on their productivity in these rooms, caused by the excessively hot environments and reduced airflow.

Other Universities. While discussing the issues they faced that negatively impacted their experience at the campus, a few students mentioned particularly positive aspects of other universities, where they would often go to study and do classwork, which they

believed should be adapted and applied to the IADE, UE campus to improve the student experience. These included (1) the existence of dedicated spaces within the library where noise restrictions were not applied, thus allowing students to freely communicate with their colleagues when studying or working on group projects; this system tackles the overcrowding of the common areas, the cafeteria, and the lounge, by allowing more students to utilise the library and consequently reducing the number of students studying and working in the cafeteria and lounge areas; (2) the existence of dedicated study rooms, and their categorisation according to guidelines; for instance, several rooms dedicated to quiet study, where noise is restricted. This system would aid students in their search for a space that met their needs; (3) a space reservation system in the library, through which students could book desks or cubicles, for a specific time slot and day, allowing them to guarantee a place to study and work on campus.

3.2 Proposed Digital Solution

In this section, we discuss the results and insights pertaining to the third stage of the focus group sessions, in which we introduced the concept of a digital product providing information on campus spaces, part of which is provided by a network of installed sensors, followed by a discussion of valued data and features, and the potential impact on students' current experience.

Valued Information/Data. When discussing what types of information on campus facilities would be most valued in supporting the search for a space to study, to do classwork, to socialise, among other activities, the following were most valued: (1) space occupancy level, allowing students to quickly know which areas and rooms are less crowded and present better chances of finding a seat in without personally checking each space; (2) current availability of the space and its schedule, allowing students to know when and for how long they may use that space; (3) air quality and room temperature, including the status of the HVAC system and ventilation/air flow; (4) equipment available in the space, such as computers, audio/visual systems and devices, machinery, and the number of power outlets (particularly, the number of available/free outlets); (5) noise level in the room; (6) Wi-Fi quality/signal strength; (7) room type, such as whether it is a standard lecture classroom, computer classroom, a hall, lab/studio, the types of tables and seating available; the preferred method of conveying this information was including a photo of the room view, which was preferred over schematics of the layout due to readability and recognition.

There was a clear preference for a qualitative presentation of numeric data through a clear rating or level system, such as indicating a rating of air quality rather than indicating the number of particles, a noise level rather than the value of decibels, or a temperature characterisation with the degrees Celsius rather than solely the latter, as this type of data is more easily understandable.

Additionally, in two of the focus group sessions, a few students mentioned their preference for conveying the occupancy and equipment available in schematic form, where, in a layout of the room, the location of equipment, outlets (both occupied and available) and seats (both occupied and available) are depicted. This preference addressed potential scenarios that participants may have given, in which occupancy (or the number

of seats available) and the number of outlets available could be misleading. For example, a seat next to a stranger or an outlet that is awkwardly located far from any seats or tables could both be listed as available but likely go unoccupied by students, giving an inaccurate and higher count.

Type of Digital Solution. All focus group sessions, except for the first, produced a clear consensus regarding the preference for a smartphone application when discussing the digital product. Two students instead recommended creating a device that would be placed in the main building's entrance and accessible to all students, rather than creating a smartphone application. They reasoned that some students might not be able to purchase a personal smartphone, in which case they wouldn't have access to the suggested remedy. The remaining students disagreed with the idea, stating that it would not be as useful as they would only have access to the information while on campus and at that specific location. The argument was also rejected because it is improbable that a student at a private university would not own or be able to afford a smartphone. There was no consensus on whether this solution should be developed as a standalone application or integrated into an already existing application (a platform in which students have access to their course materials, their grades, communicate with faculty, submit classwork, amongst others). While participants agreed that it would not make sense to integrate the two digital products due to the difference in scopes, as there was no alignment in their purposes or functions/features, the existence of more than one application for the same university was deemed unnecessary. To address the latter, in two focus group sessions, the development of a web version with limited functions was suggested, to allow students who might not want to have more than one app to still have access to the solution.

Impact and Value. Overall, all students attributed value to the digital product and recognised its positive impact on the student experience at IADE, UE. This impact related, particularly, to the improvement of student comfort by (1) aiding them in the discovery of available spaces to work in (improving the number of the spaces they considered); (2) reducing the effort in finding a space that meets their particular needs, and (3) allowing them to plan their schedule according to the availability and occupancy, without the need to visit the campus.

All participants agreed the solution would generally improve the experience of (1) students who already enjoy/wish to utilise campus spaces but are hindered from doing so due to the previously reported pain points (see 3.1.3), and (2) for whom it is practical to stay on campus, due to gaps in their schedule, transportation limitations, living far from campus, or having extracurricular activities.

However, the perceived impact on their personal experiences varied: (1) participants who preferred to study and work by themselves and/or at home did not believe this solution would motivate them to change their habits and spend more time on campus facilities. They also did not believe it would actively attract students to spend more time at IADE, UE; (2) participants who already demonstrated a pre-existing desire to utilise campus facilities, but were deterred by previously mentioned pain points, believed the solution would have a great impact on their own experiences; these participants attributed greater value to the digital product.

Thus, the impact of the digital solution is greater in its ability to retain students on campus by improving their conditions, rather than in attracting and motivating students to start utilising campus facilities more frequently.

Foreseeable Issues and Challenging Scenarios. Throughout the sessions, while discussing the different applications of the digital product, some participants raised possible issues and challenges in the form of scenarios; these scenarios focused on the same two common concerns: (1) coexisting in study rooms – by allowing students to use the available classrooms as study rooms, when available, participants were concerned that they could be easily disturbed by others, e.g., "If a student is preparing for an exam, alone in a quiet classroom, and a group comes in to work on project, the noise might disturb the first student, who will end up moving", and "If I arrive to a study room and there is one other person there, maybe I am not comfortable in sharing, by myself, the space with someone I do not know." (2) adherence to guidelines and rules, and the challenge of monitoring and ensuring the guidelines are being followed in each available room, e.g. "Who will be checking every room to make sure it is orderly?", and "What if people end up using the classrooms to eat, and leave it dirty?".

These raised issues were particularly interesting as they would derive from a lack of familiarity with the concept of study rooms, conveying the feeling of this concept as foreign, thus raising logistical and practical concerns in these particular participants. In such situations, students who had mentioned studying and working at other universities (such as at Instituto Superior Técnico, ULisboa) dismissed these concerns by stating that study rooms, and the mixed use of classrooms as study rooms, is "very common" and "they would work as they already do in other universities".

A common concern that was raised in all focus group sessions was how this solution, its development, and its respective cost, would potentially raise the students' tuition. This was frequently mentioned, particularly when discussing potential features and app capabilities.

Other Features/Functions. During focus group sessions, participants discussed amongst themselves what other functions or features the digital product should encompass in order to address their needs and pain points, from which we were able to establish the following: (1) student reservation system, allowing students to book desks/seats for particular time slots. The possibility of students reserving entire rooms was discussed but eventually dismissed, as it would not be an efficient use of the available spaces; thus, most students agreed that room reservations should be a faculty-only feature; (2) waiting list integration with the application, allowing students to view and register for the waiting lists of labs and studios; (3) list of equipment available at the front desk. Currently, students are able to personally go to the front desk, request and check out equipment such as adapters, cables, and extension cords. Thus, for their convenience, it would be useful for that process to be digitised, allowing them to view what is available in inventory and reserve them through the app; (4) application-student collaboration, allowing students to report on the status of the room through the app, not only confirming the data provided by the sensors, or reporting existing discrepancies or errors, and potentially compensating the sensors lack of precision (e.g., the number of available seats or available equipment), as well as on characteristics which are not provided by sensors, such as the level of cleanliness/tidiness of the room or incorrect scheduling; (5)

ability to view which materials are available at the library, and suggest materials to be added; (6) information and timely alerts for workshops and events occurring on campus that may be of the student's interests, as participants complained to only knowing these initiatives after they had already occurred.

Additionally, in one particular focus group, one student suggested and endorsed the idea of installing video surveillance in all classrooms, labs, and common areas, for the safety of the students, the faculty, and IADE, UE equipment, and to ensure accountability in any instances of property damage or conflict. After discussing amongst them, participants agreed on the use of video surveillance, albeit only in specific spaces, particularly studios, and rooms that contain expensive materials, machinery, and equipment. When asked about privacy concerns, student discomfort or any negative feelings towards surveillance, two students reported that "when the use of video surveillance is justified, and we are aware of the why, most people will likely be accepting," while a third student mentioned that "surveillance cameras, nowadays, are everywhere; we are constantly filmed in any private property, and no one minds".

4 Conclusion

Focus group sessions revealed that students at IADE, UE face challenges with campus facilities, particularly regarding the availability and suitability of spaces for group and individual activities. Students primarily come to campus to collaborate on projects and access specialized resources. However, common areas are often overcrowded, making it difficult to find appropriate study and collaboration spaces. The lack of dedicated study rooms and unclear policies on using empty classrooms further exacerbate these issues.

The proposed digital solution, providing real-time information on campus facilities, was perceived as a beneficial tool to improve the usability and efficiency of campus spaces, and particularly to have a positive impact and add value to the current student experience. However, its potential impact may be limited to improving the experience of those who are already inclined to use campus facilities rather than changing the habits of (and attracting) those who are not.

Insights revealed students valued features and data that would allow them to check the status of campus spaces before arriving, as it would be a useful tool for their planning, and that would facilitate the search process, reducing the frustration associated with finding available spaces. Real-time data related to availability and occupancy, air quality, and available equipment and power sockets were particularly valued, as these elements directly address the primary pain points identified in their current experiences. The student-student and researcher-student collaboration during focus group sessions allowed us to identify and refine additional features or functions that would address other issues in the students' journeys, such as a desk/seat reservation system for students, student feedback and reporting features related to discrepancies in sensor data, labs and studios waiting lists integration, equipment reservation, and event and workshop notifications.

The findings of this study convey the current student experience on campus, and how it is impacted by issues in the campus infrastructure which do not meet their needs. While we were able to validate the potential of the proposed solution to significantly mitigate

some of the identified pain points, this study underscores the importance of continuous infrastructure and administrative improvements to better accommodate student needs and foster a more conducive environment. Future developments include the application of the collected insights to map user journeys and identify points of impact of the solution, and define information architecture based on the valued features and data types that were identified.

It is important to consider that all participants were enrolled in the same course, and in the same year, which may lead to skewed results. The nature of their course may also lead to a bias in their opinions regarding the digital solution. Additionally, the pre-existent dynamics and relationships between the participating students in the focus groups, and their personalities, directly affected the level of participation and the depth and length of discussions. Thus, levels of participation and productivity varied across the different sessions.

These findings address (1) the common experiences, motivations and challenges that are faced by university students at campus facilities, and may be prevalent in other higher education institutions; (2) the preferences of students regarding IoT solutions in campus facilities, particularly, valued data and information on campus spaces, and features/functions relevant for their experience. Such insights are potentially valuable for similar initiatives in other higher education institutions. Nevertheless, each campus has its own characteristics and dynamics, and additional studies would be necessary to ensure the solutions effectively address the specific needs and contexts of other institutions. Further research should consider diverse university environments and a broad student and faculty sample to enhance the generalizability and applicability of these findings across different educational settings.

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