

Article

Digital Transformation in University Architecture: Optimizing Construction Processes and User Experience through CAMPUS 2.0 at Pontificia Universidad Javeriana

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Abstract: The integration of digital technologies in managing technical and design information is transforming architecture, engineering, and construction (AEC) processes within educational institutions. Despite this, construction education lacks practical, interactive learning tools, and there is insufficient collaboration between academia and the construction industry. To address these challenges, the CAMPUS 2.0 project at Pontificia Universidad Javeriana developed a web-based platform that integrates building information modeling (BIM) and gamification elements. This platform improves project coordination, facilitates interdisciplinary learning, and enhances the management of technical and design information for campus buildings. CAMPUS 2.0 also promotes collaboration and active user engagement, filling a critical gap in the practical tools in construction education. This study assesses the usability of CAMPUS 2.0 among 235 students, teachers, and staff members, demonstrating a positive impact on the university community. The findings provide insights into how digital tools can improve project management, interdisciplinary collaboration, and knowledge sharing within educational settings, offering broader implications for other institutions.

Keywords: digital technologies; community impact; construction processes; information management; interactive tools; interdisciplinarity; sustainability



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1. Introduction

Interdisciplinary collaboration between design and structural engineering is crucial for the successful delivery of architectural projects. Effective project management ensures that all stakeholders—designers, engineers, and construction managers—work together seamlessly to achieve project goals [1]. Digital technologies, such as building information modeling (BIM), virtual reality (VR), and augmented reality (AR), have become essential tools in architecture, engineering, and the construction (AEC) industry. These tools enhance communication, reduce errors, and improve coordination in design and construction activities [2,3]. Digital technologies have also played a critical role in improving project management by providing immersive and interactive experiences that simulate real-world scenarios [3]. For example, digital supply chain management streamlines processes, enhances collaboration among stakeholders, and improves project outcomes [4]. Additionally, engaging suppliers, contractors, and strategic partners on a common digital platform strengthens the relationship between industry and academia, with digital tools further facilitating communication between stakeholders [5]. Documenting construction processes adds significant value to project management. Analyzing these processes to

identify best practices, lessons learned, and areas for improvement contributes to the continuous improvement of project management methodologies on university campuses and beyond [6]. By fostering interdisciplinary collaboration through the digital supply chain, documenting the building lifecycle and its construction processes, and using innovative teaching methods that allow second design opportunities, stakeholders and educational institutions can create more engaging, effective, and relevant learning environments [7]. This is achieved through comprehensive digital platforms that bridge the gap between theoretical knowledge and practical application.

Based on the background presented above, this article provides a comprehensive overview of a web platform developed to compile detailed information about the construction processes of the buildings on the campus of the Pontificia Universidad Javeriana (PUJ) in Bogotá, Colombia. CAMPUS 2.0 aims to improve project management in educational construction processes, focusing on interdisciplinary collaboration, communication, and practical learning experiences. This study addresses the following research question:

How can digital technologies be effectively integrated into project management methodologies to improve construction outcomes in university settings?

Through the case study of PUJ's recent campus developments, the study highlights the role of digital innovation in modern construction management and its potential to transform both education and project execution. While the primary focus of this study is on project management, the findings also highlight the potential for future research into how platforms like CAMPUS 2.0 can enhance educational and learning experiences. Although specific learning theories and types are not discussed in this paper, these aspects could be explored in future studies, particularly in academic contexts that prioritize educational outcomes and learning methodologies.

The construction of the Pontificia Universidad Javeriana campus represents a significant effort to create a state-of-the-art academic and educational environment. Located in Bogotá, Colombia, the campus was developed with a vision that integrates modernity, functionality, and sustainability. With architecture that blends traditional and contemporary elements, the campus offers not only advanced infrastructure facilities, but also green spaces and common areas that contribute to the well-being of the university community. This approach ensures a dynamic and enriching environment that reflects the values of academic excellence and social commitment that characterize PUJ.

PUJ's campus, covering approximately 350,000 square meters, serves a student population of around 24,000, including undergraduate and postgraduate students. The campus has seen the development of several notable new buildings over the past decade, such as the Gerardo Arango S.J. Building (School of Arts), the Jose Gabriel Maldonado Building (Laboratories of Engineering School), the School of Sciences Building, and the Sapience Tower.

By examining the construction processes and information management practices of these new buildings, this study aims to demonstrate the benefits of integrating advanced digital technologies into construction management.

The novelty of the present research is to use the university campus as a dynamic educational tool by integrating real construction and project management practices into the learning environment. In addition, the study aims to provide students and the university community with practical insights and hands-on experience, thereby enriching their educational experience. An important aspect of the study is the creation of comprehensive documentation of the construction process. This documentation will provide valuable historical records and insights for future projects and will contribute to the advancement of construction management knowledge by identifying best practices and areas for improvement. Finally, the research aims to set a precedent for digital innovation in educational institutions.

The following sections discuss the context of digital technologies in AEX, the development and implementation of CAMPUS 2.0, and the impact of these innovations on university construction projects and educational practices.

2. Background Review

2.1. Innovation and Development in the Construction Industry

Construction innovation management has evolved significantly, encompassing not only new technologies but also methods, materials, and practices that improve the efficiency, sustainability, and quality of construction projects. Slaughter [6] classifies construction innovation into five types: incremental, modular, architectural, systemic, and radical, each requiring different levels of adaptation within traditional existing construction practices.

A key challenge in managing innovation is the industry's resistance to change, often due to its conservative nature and the fragmented processes. To overcome this, a culture of innovation is essential [8], as companies that invest in innovation gain significant competitive advantages [9]. Berardi [10] highlights that training and development enable employees to be better equipped to implement new technologies and methods effectively. Digital technologies, particularly building information modeling (BIM), have revolutionized the construction industry by improving precision, reducing costs, and enhancing customization [11]. BIM facilitates collaboration among stakeholders and enables 3D visualization, simulation, and analysis, which have enhanced decision making and resource optimization [12]. In terms of sustainability, innovations in construction have allowed the development of more energy-efficient buildings with a lower environmental impact. Technologies such as energy management systems, green building or eco-friendly construction materials, and sustainable construction practices are revolutionizing the way buildings are designed and constructed. Berardi [10] states that the integration of sustainable practices in construction benefits the environment and can also result in significant long-term savings.

Additionally, advanced construction methods, like prefabrication and 3D printing, allow faster, more accurate building processes, significantly improving productivity and reducing costs [13]. Collaboration between industry and academia further fosters innovation, accelerating the transfer and the implementation of new technologies [14].

2.2. Digital Transformation in Construction Information Management

Historically, information management in construction has been manual and prone to errors. However, digital technologies such as BIM have transformed the landscape by enabling more accurate and collaborative management of data throughout the project lifecycle [15]. BIM integrates geometrical, material, cost, and time information, improving visualization, collaboration, and decision making [1].

In addition to BIM, other digital tools, such as the Internet of Things (IoT), big data, artificial intelligence (AI), or real-time collaboration platforms, are revolutionizing information management in construction. These tools collect real-time data from sources like sensors and mobile devices, resulting in greater transparency and project control [16]. Cloud-based systems have also been a key factor in the innovation of information management in construction. These systems allow data to be accessed and updated in real-time from any location, facilitating collaboration and coordination between different work teams [17]. Digital twins are virtual replicas of buildings that offer additional benefits by providing up-to-date information for operations and maintenance [18].

In summary, digital technologies are transforming construction information management, by improving accuracy, collaboration, and decision making, while also contributing to sustainability and cost reduction.

2.3. Innovation Cases for the Consolidation of Technical Information in Construction

The AEC industry is actively adopting digital technologies to improve efficiency, reduce building waste, increase productivity, and enhance safety and sustainability. Despite this, traditional practices still dominate in many areas [19]. Manzoor et al. [20] indicated that the use of digital technologies (DTs) in the AEC industry is transforming the relationship between the construction process and human behavior, and their impact on user behavior is becoming increasingly important to assess. DTs, such as BIM, AR, VR, AI, photogrammetry, radio frequency identification devices, geographic information systems (GISs), global

positioning systems (GPSs), wearable safety devices, quick response code (QR), robotics, block chain, onsite mobile devices, and laser scanning devices, are helping to improve collaboration and project outcomes, though adoption remains slow in some regions [21]. Industry technologies like IoT are beginning to transform the construction sector, offering opportunities to improve project safety, efficiency, and environmental impact. However, challenges related to technology adoption, government policies, and organizational culture persist [22].

It is important to emphasize the importance of digital transformation for sustainable market success and competitiveness in the digital age, and companies should consider some facts to remain competitive in the digital age. These include how to further develop existing business models; how to use real-time product and machinery usage data; the impact of artificial intelligence on corporate culture and organizational development, where digital methods can be used in products and services; the extent to which parts of the value chain can be fully digitalized; and who could be suitable partners for platform-based collaboration [23].

In addition to the above, not only is digital transformation crucial but the construction industry for future adoption needs to plan eco-innovative practices to continue adopting them. The construction industry's slow pace of change necessitates 'bottleneck thinking' to address issues and barriers. The governments need to be more flexible and decisions on eco-innovative practices should involve dialogue and consensus with stakeholders. These findings provide realistic insights for practitioners to implement in their decision-making processes. Eco-innovative practices also strongly mediate the relationship between these factors and the future adoption likelihood, and they are positively related to financial profitability [24].

The adoption of Industry 4.0 technologies has far-reaching implications for the construction industry, including economic benefits, improved safety, and sustainability. However, there are political, economic, social, technological, environmental, and legal challenges to be addressed.

2.4. Innovation Cases of Technical Information Consolidation in University Context

University campuses are integrating advanced technologies, such as BIM, digital twins, and VR, to enhance operational efficiency, user experience, and sustainability. These innovative technologies improve decision making, resource allocation, and overall campus performance by providing real-time data and insights into infrastructure management [25]. By embracing these innovations, universities can create smarter, more connected campuses that cater to the needs of students, schools, and staff while promoting environmental stewardship and long-term sustainability. For example, BIM was used to assess carbon emissions in prefabricated buildings at Southeast University, Nanjing, China, demonstrating the potential of digital tools to promote sustainable construction practices [26]. Similarly, at Virginia Tech, VR was employed to create immersive campus tours, providing an engaging and innovative way to display campus facilities [27]. The implementation of energy-saving action plans for Taiwan Tech, a university campus in Taiwan is another case; it utilized smart energy management systems, elevator power recovery devices, circulating fans, and lighting delay switches and replaced old air conditioners, fluorescent lamps, and high-sodium streetlights with more energy-efficient alternatives [28].

The research in [29] highlights the challenges associated with digital twins (DTs) on the Texas A&M University campus, including cost, complexity, interoperability, and data integration. The proposed system addresses these issues by creating a robust data integration framework, representing data in a spatial-temporal format, and developing user-friendly interfaces and dashboards for data visualization and analytics. The study demonstrates the system's effectiveness, adaptability, and real-world applicability through case studies in domains such as fire accident management and urban planning. The system's interactive features allow users to explore, visualize, and analyze data related to class distribution and building capacity, supporting data-driven decision making.

Another case is that of the Pontificia Universidad Javeriana in Colombia, which investigates the effectiveness of alternative teaching methods and digital technologies in the education of architecture and construction engineering students. The research focuses on the use of a mobile application (CAMPUS Javeriana) that integrates various digital technologies, such as construction videos, photos, BIM models, virtual and augmented reality, and infographic images, to enhance learning outcomes. This app enhanced learning outcomes by offering students interactive, hands-on experiences that bridged the gap between theory and practice [30].

In summary, the integration of digital technologies, such as building information modeling (BIM), digital twins, and the Internet of Things (IoT), represents a significant advancement in the management of technical information on university campuses. This article addresses existing research gaps and leverages the opportunity to utilize comprehensive data from the Pontificia Universidad Javeriana (PUJ). It focuses on evaluating the CAMPUS 2.0 platform as a tool to enhance the management of information related to the construction and maintenance of buildings on the PUJ campus.

3. Methodology

The research methodology was designed to systematically develop, implement, and evaluate the CAMPUS 2.0 platform, to ensure that technical objectives were met. The approach adopted a phased structure guiding the process from initial planning to final validation. Each phase contributed essential elements to the overall goal of creating a web-based learning tool that improves the university community's understanding of the architectural and structural design of campus buildings.

This methodology integrates both qualitative and quantitative elements. The process of building this platform and its validation is depicted in Figure 1.

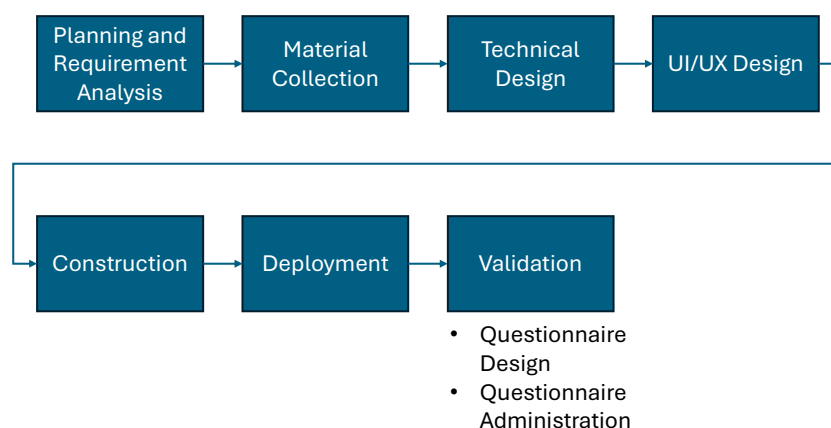


Figure 1. Methodology.

The initial phases focused on planning, content gathering, and technical requirements, while the subsequent phases emphasized user experience (UX) design, technical implementation, and iterative testing. The semantic differential method was critical to the validation process, as it allowed a detailed assessment of user perceptions, focusing on usability, desirability, and credibility. Combining user-centered design principles with structured feedback ensured that the platform was functional and that it aligned with user needs and preferences. These phases of the methodology are detailed below:

a. Planning and Requirement Analysis:

The process commenced with a thorough planning and requirement analysis phase. This involved identifying the essential features for the platform, such as user authentication, quiz creation, and form submissions. To gather input, we conducted comprehensive surveys and focus groups with students and professors, aimed at understanding what information

about campus buildings would be the most valuable and in what formats. A strong interest was shown in learning about the designers and their intentions behind the projects.

b. Material Collection:

The material collection phase was pivotal in sourcing the foundational content for the CAMPUS 2.0 platform. Collaborating closely with the Office of Infrastructure Development of PUJ, we identified four of the newest and most significant buildings (Figure 2), each with extensive technical information:

- Gerardo Arango S.J. Building: School of Arts;
- Jose Gabriel Maldonado Building: Laboratories of the School of Engineering;
- School of Sciences Building;
- Sapiencia Tower.



Figure 2. List of buildings incorporated in CAMPUS website.

We engaged with key members of the design teams, including architects, structural designers, and construction managers. Through detailed interviews, we produced over 12 thematic videos covering various topics, such as general, architectural, and structural descriptions, challenges and solutions, and sustainability initiatives. Extensive visual documentation, including photographs and videos of construction processes, sustainability certifications, awards, and more, complemented these interviews. This phase also involved consolidating architectural and structural drawings, forming a rich content base for the CAMPUS 2.0 platform.

c. Technical Design:

This phase focused on selecting the appropriate tools for deployment. Unlike the previous version of CAMPUS, which involved a mobile app with a WordPress [31] backend, CAMPUS 2.0 was developed exclusively as a web-based application to enhance accessibility across devices. In addition, ensuring the security of user data is crucial. This includes protection against malware, phishing, and other types of attacks.

WordPress was selected as the content management system due to its cost-effectiveness and the seamless migration from the previous version. To extend the functionality of WordPress, several key plugins were integrated. Elementor was used to create visually engaging and easily editable content pages. The WP Forms Lite [32] plugin enabled custom form submissions, which were essential for gathering feedback, while Quiz Maker [33] facilitated the creation of interactive quizzes to assess student learning. Security was also a priority; so, plugins like AuthLDAP [34] and Loginizer [35] were implemented to ensure secure user authentication and protect against potential threats. Finally, the Simple Page

Access Restriction [36] plugin was used to control access to some pages, and WP Mail SMTP [37] was used to facilitate email delivery configuration.

All components were thoroughly tested on a private server before the platform's full deployment to ensure a stable and secure environment for users.

d. UI/UX Design:

Using Elementor, the design team created visually appealing and functional layouts for the platform. The drag-and-drop interface of Elementor facilitated rapid prototyping and design adjustments based on user feedback, ensuring an intuitive and engaging user experience. To further enhance engagement, gamification elements were integrated into each building's page through quizzes, which were specifically designed to encourage active participation and retention. These quizzes were placed strategically within the platform to motivate users to explore and interact with the content more thoroughly.

e. Construction:

In this phase, the team uploaded the teaching materials collected during the material collection phase using WordPress content management features. The Quiz Maker plugin enabled the creation of 15 "Learning Capsules", which are quizzes designed to assess student comprehension of the building characteristics. Each quiz includes a timer and points system, allowing users to track their progress and receive personalized feedback. At the end of each quiz, users receive detailed feedback on their performance, which either encourages them to retry for a better score or congratulates them for their success. This system is designed to make the learning experience more interactive and motivating, enhancing user engagement through competitive elements and immediate feedback.

f. Deployment:

After thorough testing, the site was transferred from the test server to a production server, which made it accessible to the public. This critical step was carried out by the University's TIC (Technology, Information, and Communication) teams, ensuring that the platform was securely hosted and accessible online. Continuous monitoring was implemented post-deployment to address any issues promptly, ensuring the platform's reliability.

g. Validation:

The validation phase was designed to rigorously assess the effectiveness and usability of the CAMPUS 2.0 platform. A semantic differential study [38] was employed due to its proven ability to capture user perceptions across a range of bipolar attributes, such as "Efficient—Inefficient" and "Intuitive—Confusing". This method was chosen specifically because of its established relevance in evaluating user experience (UX) design and web navigation, which are core elements of the CAMPUS 2.0 platform. The semantic differential has been widely utilized in various design fields, including product design [39], emotional design [40], and graphic design [41], and more recently, its use has been extended to UX [42] and the navigation experience of a web resource [43]. By measuring users' perceptions along a series of bipolar scales, this method allows a quantitative evaluation of subjective experiences, making it an ideal tool for capturing nuanced feedback on both the functionality and emotional engagement offered by the platform.

The method aligns with the primary objective of this study: to assess users' overall experiences with the platform, particularly its usability and interface design, without directly measuring learning outcomes, which had already been evaluated in prior studies [30]. It was important for this study to focus on the user experience and perceived value of the platform to identify areas for improvement that could further enhance the learning environment.

The study involved a representative sample of students, professors, and administrative staff, ensuring a diverse range of technological proficiency. The flexibility of the semantic differential method allowed it to be applied across this broad user group, considering the varied capabilities and expectations of its intended audience.

A detailed questionnaire, distributed online using Google Forms, utilized seven-point bipolar scales to assess key criteria grounded in user experience principles. These scales established a direct link between the seven principles from [44] and the semantic differentials applied to evaluate them. For instance, system usefulness was measured by the relevance and efficiency of the information provided, while usability was evaluated through factors such as ease of use, simplicity, and intuitiveness. Desirability corresponded to aesthetic elements and overall user satisfaction; findability focused on the visibility and accessibility of information; and accessibility addressed ease of use for all users, regardless of their abilities. Credibility was associated with the trust users placed in the system and the accuracy of its information. Lastly, overall value was determined by the perceived relevance, efficiency, and usefulness of the information from the user's perspective.

Data analysis was conducted using statistical techniques to interpret the feedback. By averaging responses across the scales, the research team identified trends and areas for improvement. This comprehensive analysis validated the platform's strengths and provided actionable insights for continuous development. The findings emphasize the platform's potential to significantly enhance user experience and guide its future evolution.

4. Results

4.1. Website

The website consists of nine distinct sections, as observed in the top part of Figure 3, each designed to provide a comprehensive range of informational and educational resources. The primary goal of this website is to create an innovative digital space that facilitates the storage, management, and dissemination of technical data and detailed information about the buildings on the Pontificia Universidad Javeriana (PUJ) campus. This digital approach allows a greater accessibility for students, professors, and the broader educational community, as well as external individuals interested in the architectural and infrastructural developments at PUJ.



Figure 3. Homepage CAMPUS website 2024.

At the heart of the site is a Navigation Menu that directs users to key sections, including “Campus 2.0”, which outlines the evolution of the Research-Creation Project from its first stage as CAMPUS 1.0, along with the main objectives of the Learning Laboratory in Structures and Construction. A video further elaborates on the technologies and innovative strategies used in learning about the construction processes at the university. A summary of all the contents created and organized on the website is presented in Figure 4.

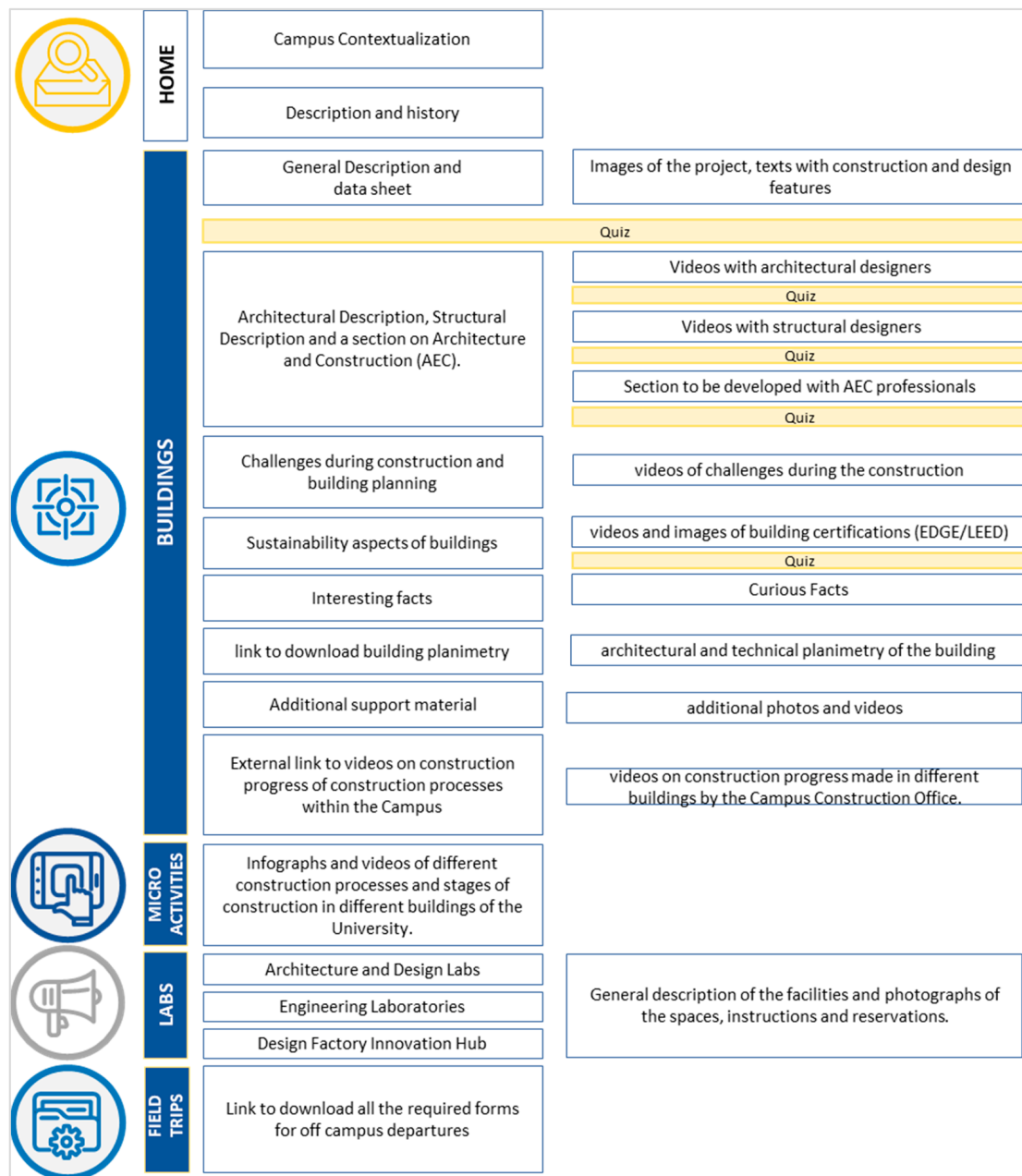


Figure 4. Conceptual frame summarizing all contents developed.

In the “buildings” section, there is detailed content on the general, architectural, structural, and sustainability aspects of four buildings: (1) the Gerardo Arango Puerta, S.J. Building; (2) the School of Sciences Building; (3) the Laboratories of Engineering School Building; and (4) the Sapience Tower Building. Each building’s section includes a general overview with a technical description, a brief approach to its architectural design and structural system, the significant engineering and construction elements, and the unique challenges and interesting facts about its development.

A key feature of the platform’s design is the integration of gamification elements to improve user engagement. Each building’s page includes a quiz (as shown in Figure 4) within the “Learning Capsules” section, which tests users’ knowledge of the building’s characteristics. Each quiz is structured with a points system and a timer to provide a competitive aspect to the learning process. Upon completion, users receive feedback as a percentage score (see Figure 5), along with personalized messages that either encourage them to retry for a higher score or congratulate them for their success. This gamified

approach not only makes the learning experience more interactive, but also motivates users to continue engaging with the content. This fosters a sense of accomplishment and progression. Including timers and point-based assessments has shown a positive effect on user behavior, increasing participation and retention. This gamification strategy invites users to explore the campus more thoroughly and encourages them to navigate deeper into the digital platform, promoting continued interaction with the digital and physical campuses.

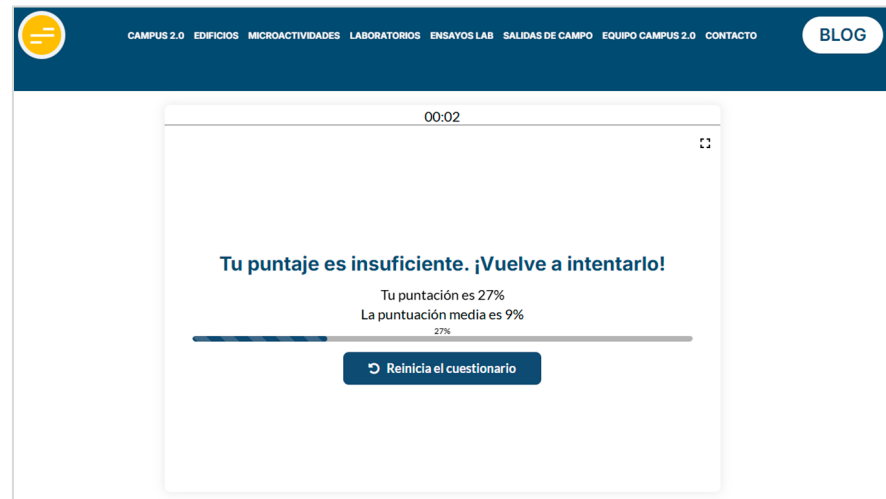


Figure 5. Sample of quiz result.

Additional sections, like “Micro activities”, have a compilation of content from different phases of the construction processes, providing universally applicable insights that are vital for any construction project. The “Laboratories” section highlights three practical laboratory sets on campus related with the construction industry: the six laboratories of the Architecture and Design School, the Engineering Laboratories, and the Design Factory, an innovation hub connected to a global network of over 42 universities. The “Lab Tests” section offers over 20 video demonstrations of practices conducted in the Civil Engineering Laboratory, while the “Field Trips” section provides guidelines for organizing and executing educational site visits.

The last section introduces the team behind CAMPUS 2.0, comprising professors, practitioners, and strategic allies who have contributed to the project’s success. While the platform offers unrestricted access to most of its content, it is important to highlight that over one hundred unique resources have been developed. Of these, eight exclusive materials are restricted to members of the Pontificia Universidad Javeriana (Figure 6), ensuring that exclusive materials are available to the university community.



Figure 6. Main menu, School of Science Building’s planimetry restrictive content.

The website is accessed here: <https://www.javeriana.edu.co/construlab/> (Accessed on 23 September 2024). The website's content is structured around three key pillars: (a) building life cycle, (b) building supply chain, and (c) second design opportunities. These concepts are integral to the digital integration of the AEC industry and its project management within an educational context, promoting virtual spaces that elucidate the complexities of the construction process through effective information management. The following paragraphs and figures demonstrate how these concepts are integrated into the website's content:

a. Building Life Cycle

The site provides an exploration of the building life cycle, illustrating the journey of a building, from conceptual plans to final completion. Through a series of interconnected videos, plans, drawings, and images, the content highlights the critical role of sustainability, efficiency, and coordination at each stage of a building's life. This approach emphasizes the importance of managing a building's lifecycle to ensure long-term value and responsible project management.

Figure 7 provides an example of this type of content, focusing on the construction process of the Laboratories of Engineering School (pouring of a concrete floor). The videos and images associated with this building show the integration of design and digital technologies and how these elements contribute to the overall construction process.

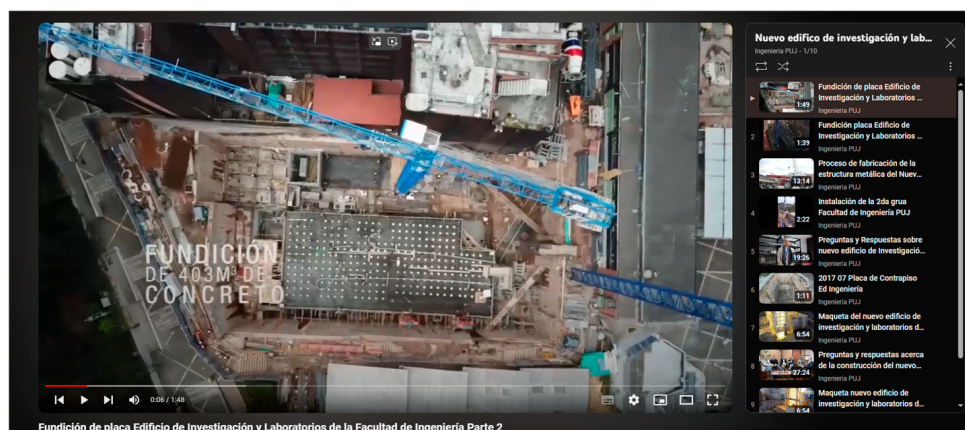


Figure 7. Videos on the CAMPUS 2.0 website: pouring of a concrete floor.

b. Building Supply Chain

The building supply chain section of the website visually explains the flow of materials, tools, personnel, information, and other resources essential to the construction of a building. This content demonstrates the coordination between suppliers, manufacturers, and contractors, which is critical to maintaining project schedules and ensuring quality.

Figure 8 is an infographic that illustrates the operational processes involved in various construction activities. The figure shows the work crews, materials, and procedures necessary to carry out a specific construction process. It also includes the work tools, the moments in which they should be used, and how to use them. The infographic description is accompanied by videos that allow users to observe the on-site experience of the construction process.

The importance of supply chain management is also evident in the designer interviews available on the site, where stakeholders are frequently mentioned. In addition, to provide users with a deep understanding of the project participants, each building section includes detailed information about the key stakeholders involved, as shown in Figure 9.

Figure 9 shows an example from the Science School Building, where the contributions of the architect, structural engineer, and other contractors are prominently displayed.

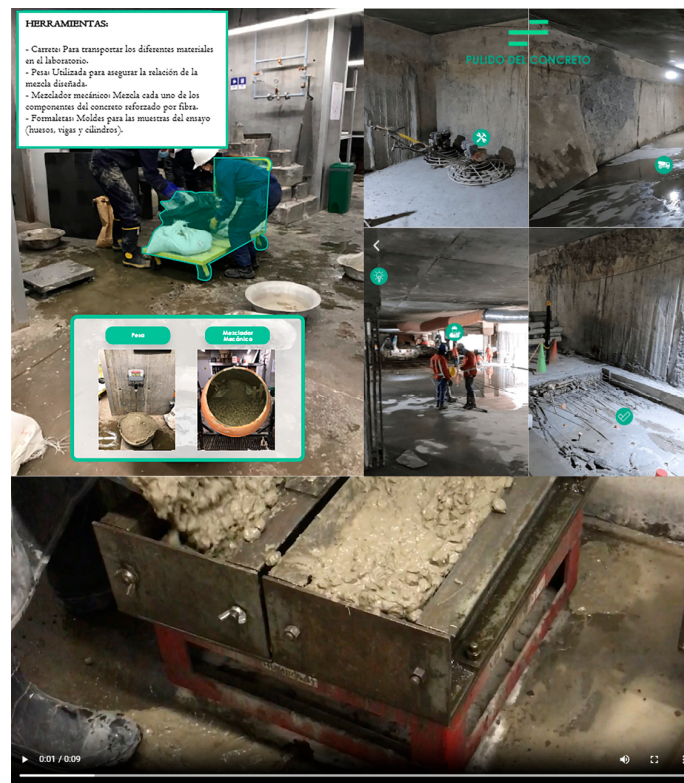


Figure 8. Building materials, tools, and personnel for construction processes.

Architectural Designer Bogotá Architecture Workshop, Daniel Bonilla
Structural Designer CNI Consulting Engineers SAS
Foundation Geofoundations
Builder ARPRO - Architects Engineers SA + SuperMetal
Supervision: Gutierrez Diaz and CIA SA

Figure 9. Stakeholders list included in each building description.

c. Second Design Opportunities

The second design opportunities segment brings the concept of rethinking and repurposing existing structures to life by allowing users to explore architectural and structural processes. For example, in Figure 10, an image of a construction process for a steel structure in the Science School Building can be viewed Figure 10a and contrasted with the information presented in the plan drawings Figure 10b.

This capability illustrates how buildings can be redesigned or retrofitted to meet new needs or improve sustainability. Users are provided with original plans and insights into the construction processes that support these transformations. This approach emphasizes the conservation of resources and the creation of innovative solutions to extend the life and functionality of buildings, in a manner that is consistent with the design, engineering, construction, sustainability, and economic goals for the lessons taught in architecture and engineering.

By providing access to detailed plans, construction processes, and examples of successful retrofits, the website not only highlights the potential for sustainable and innovative design, but also serves as a valuable educational resource for students and professionals alike, reinforcing key principles of modern architecture and engineering.

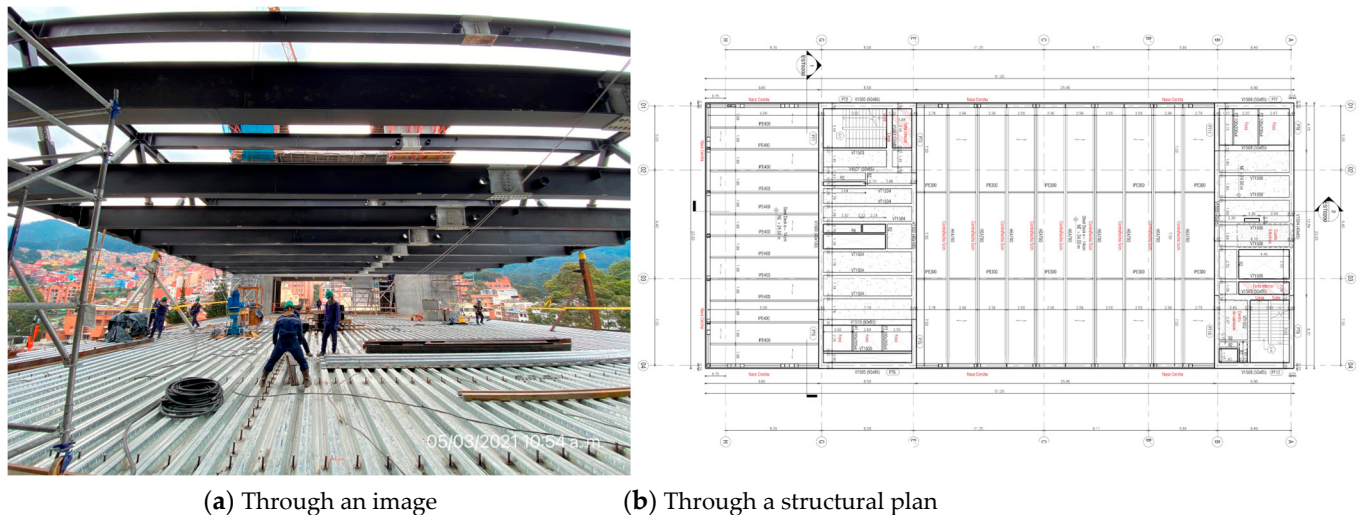


Figure 10. Example of buildings' structural composition.

4.2. User Perception: Usability and Experience

This section presents a detailed analysis of the results obtained from the usability and user experience assessments of the CAMPUS 2.0 platform, evaluated through a semantic differential method. A total of 235 participants, including 183 students, 34 faculty members (teachers from architecture and civil engineering), and 18 administrative staff members, rated various aspects on a scale from 1 to 7, with 1 representing the concept “LOW” and 7 representing “HIGH”. In general, the results indicate favorable perceptions of the platform across all user groups, though some significant differences were observed.

The usability of CAMPUS 2.0 received favorable ratings across all user groups, as shown in Figure 11. However, a more nuanced analysis revealed that these perceptions were not uniform across the groups. For example, the students remarked that the contents were more relevant to them than the other criteria evaluated due to the complexity of the information presented on the site. On the other hand, the university's staff and teachers found less meaningful content in comparison with the other aspects, given that the information was intended for undergraduates.

4.2.1. Usability

The usability ratings reveal that the teachers and staff generally had a more positive view of CAMPUS 2.0 compared to the students, as shown in Figure 11. On average, the teachers rated the platform as more “relevant” (6.56), “efficient” (6.53), and “easy to use” (6.24), while the students gave lower ratings for efficiency (5.76) and found the platform more “complicated” (5.63) and “difficult” to use (5.68).

The evaluation of the CAMPUS 2.0 usability by the teachers is more favorable, with particular emphasis placed on the aspects of “efficiency” (6.11), “interactivity” (5.06), “immersion” (5.47), and “stimulation” (6.61). This suggests they view CAMPUS 2.0 as a valuable and engaging instrument. In contrast, the students have a slightly negative perception, rating the platform lower on “efficiency” (5.56), “interactivity” (5.29), and “stimulation” (5.49) and higher on “difficulty” (5.76) and lack of “clarity” (5.63). This indicates that their perception is complex and unappealing.

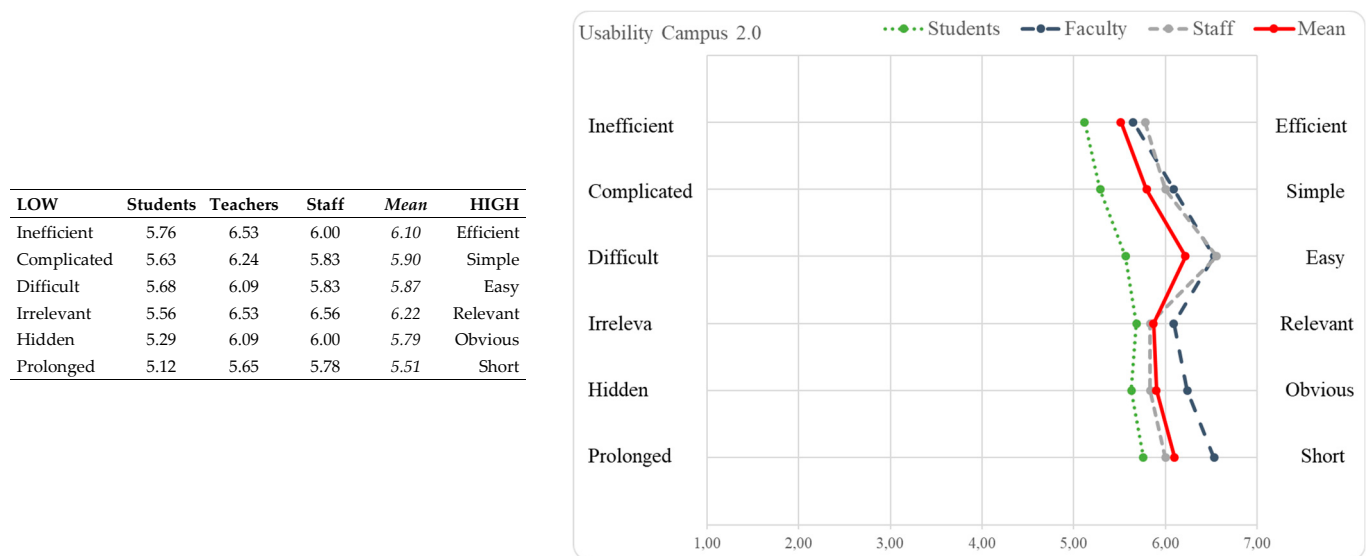


Figure 11. Semantic differential averages by groups for CAMPUS 2.0 usability.

For example, “efficiency” received an average rating of 6.10, reflecting a generally favorable perception. However, the breakdown of this rating shows that the students gave a lower average of 5.76, while the teachers rated it significantly higher at 6.53, and the staff gave a mid-range rating of 6.00. This may suggest that the students had difficulty using the platform efficiently, possibly due to a less intuitive interface or a steeper learning curve compared to the teachers and staff, who may have more experience with similar tools or more specialized needs, perceived the platform as working well.

In terms of “simplicity” and “ease to use”, a similar pattern emerges. The students rated the platform as more “complicated” (5.63) and “difficult” (5.68), while the faculty members gave higher ratings for both: 6.24 and 6.09, respectively. The higher ratings from the teachers and staff may indicate that these groups found the platform’s design and interface to be in line with their expectations or usage patterns, while the students may require more guidance or additional training might be necessary. This is an aspect that seems to make sense, because the validation time with the students was shorter than with the other users, due to availability.

In relation to “relevance” and “obviousness”, the analysis highlights usability concerns, particularly for the students. The relevance of the platform’s features was rated lower by the students (5.56), compared to the significantly higher ratings from the teachers (6.53) and staff (6.56). Similarly, the “obviousness” of the platform—how easily users can navigate and locate information—was rated lower by the students (5.29) than by the teachers (6.09) and staff (6.00). This indicates that the students may find some of the content of the platform less relevant to their needs or may find it challenging to identify the most pertinent features.

Overall, the usability analysis shows a clear trend: all the user groups have a positive view of the CAMPUS 2.0 platform. Some discrepancies suggest that while the platform is functional and effective for experienced users like teachers and staff, students may struggle with the interface and find it less intuitive. This could be due to differences in experience, expectations, or the specific use cases of each group. The lower (but not bad) scores from the students across various categories highlight potential areas for improvement, particularly in making the platform more intuitive, accessible, and relevant to their needs, or they suggest that additional user support for students may be needed to bridge this usability gap.

4.2.2. User Experience

The evaluation of the CAMPUS 2.0 experience shows a more diverse and complex landscape compared to its usability. Figure 12 shows that the staff members tended to give the most positive ratings, while the students consistently rated the platform lower

for various aspects. The highest rating across all the groups was “attractive”, with the staff giving the highest rating (6.25), followed closely by the faculty (6.24), indicating a strong appreciation for the visual or structural appeal of the platform. Among the students, the highest rating was for “effectiveness” (5.89), suggesting that despite some usability concerns, they found it less intuitive and more challenging to navigate.

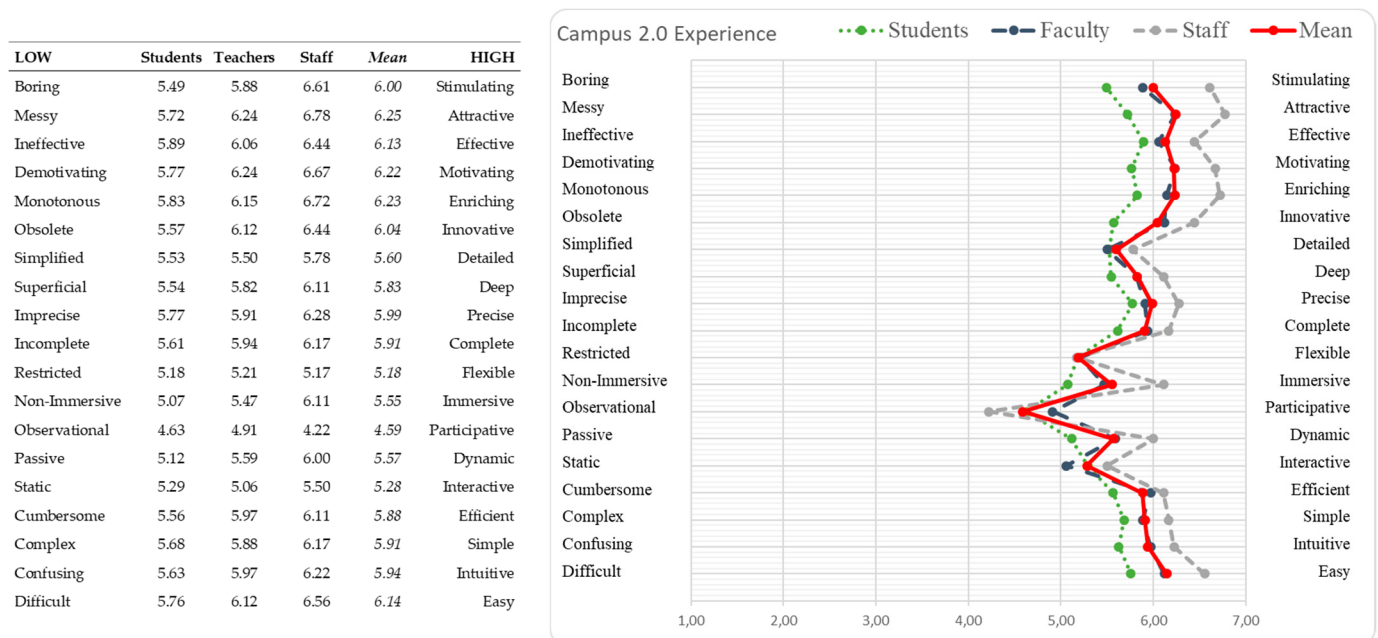


Figure 12. Semantic differential averages by groups for CAMPUS 2.0 user experience.

The general results suggest that the teachers found CAMPUS 2.0 to be a valuable, engaging, and well-designed tool. However, the lowest ratings across all the groups were for the “participation/observation” aspect, with the students giving the lowest score (4.63), followed by the teachers (4.91) and staff members (4.22). This highlights a significant area for improvement, as it shows that the platform may not be sufficiently engaging or participatory, especially for students.

By examining the data in Figure 12, several positive aspects emerge. “Attractiveness” received the highest average (6.25), with a particularly strong rating from the staff and teachers (6.78 and 6.24), indicating that the design and aesthetics of the platform were highly appreciated across the user groups, especially by those with more experience. The cases of “motivation” and “stimulation” (6.23 and 5.99) were aspects with strong positive perceptions, reflecting high levels of engagement (mainly among the teachers and staff); this reveals that the platform effectively meets the professional needs and expectations in general but suggests that there is a need to improve the platform’s ability to captivate and inspire student users.

On the other hand, the students perceive the CAMPUS 2.0 site as being more difficult (5.76) and confusing (5.63) than the other groups, suggesting that the interface may not be intuitive enough for them. This reinforces the need for additional support to ease their learning curve. The ratings for “interactivity” and “dynamism” show a similar pattern. The lower ratings from the students for “interactivity” (5.29) and “dynamism” (5.12) compared to the teachers (5.59 and 5.59) and staff (6.00 and 6.00) indicates that the students may not be fully engaging with the interactive features of the site or might find the platform less dynamic and engaging compared to the other groups.

In conclusion, the results regarding the user experience of CAMPUS 2.0 highlight the strengths and opportunities for improvement. The platform is well received by every user group, especially the teachers and staff, suggesting that it effectively meets their needs. However, the lower ratings from the students, particularly in terms of difficulty, confusion,

and interactivity, may indicate that the platform may require adjustments to better meet their needs.

4.2.3. Comparative Analysis and Correlation of Perceptions

The previous results were further examined using Pearson's correlation analysis to determine the relationships between the different user groups' perceptions. As shown in Table 1, the analysis yielded high positive correlations, with coefficients of 0.77 for usability and 0.76 for user experience between the groups.

Table 1. Pearson's correlation between user groups.

Variable		Students	Teachers	Staff
Students	Pearson's r	—		
	<i>p</i> -value	—		
Teachers	Pearson's r	0.77	—	
	<i>p</i> -value	<0.001	—	
Staff	Pearson's r	0.76	0.76	—
	<i>p</i> -value	<0.001	<0.001	—

Note. All tests one-tailed, for positive correlation.

Additionally, the *p*-values for these correlations are significantly less than 0.05, indicating that the correlations are statistically significant. These findings suggest a strong alignment in the perceptions of the students, faculty, and staff regarding the strengths and weaknesses of CAMPUS 2.0, despite some differences in specific aspects.

5. Conclusions

This study aimed to evaluate the experience and usability of CAMPUS 2.0 among its users at the Pontificia Universidad Javeriana, as part of a broader investigation into the digital transformation of university architecture. CAMPUS 2.0 was recognized as an effective tool for building information management (BIM) within a university context and showed considerable potential to improve the educational experience within the PUJ. The platform received high average ratings, which were consistently about 5 on the scale, reflecting a generally positive perception among the students, teachers, and staff. It was particularly praised for its attractiveness, motivational aspects, and enrichment potential.

CAMPUS 2.0 addresses key gaps in construction education by providing a practical interactive learning tool that bridges the gap between theoretical knowledge and real-world application in project management. The platform allows users to track the development, maintenance, and eventual decommissioning of the university infrastructure, contributing to long-term documentation and learning, an aspect often missing in educational construction projects. Additionally, its ability to present building lifecycle data supports better long-term planning and sustainability. Furthermore, the platform facilitates collaboration between academia and the construction industry by integrating the building supply chain, improving procurement and resource management, and emphasizing renovation, adaptation, and reuse opportunities within the campus environment.

While our study provides a detailed case study of CAMPUS 2.0 at the PUJ, the core functionalities and benefits offer valuable insights for other universities and institutions. Adapting CAMPUS 2.0 to different contexts involves several key considerations, like infrastructure variations, user needs and expectations, scalability and integration, and resource and support requirements.

In addition, this paper acknowledges the potential for future research into how platforms like CAMPUS 2.0 can enhance educational and learning experiences. While this study did not explore specific learning theories or types, the platform's demonstrated ability to bridge the gap between theory and practice presents valuable opportunities for future research. These educational aspects, though beyond the scope of this paper, may be more appropriately explored in studies with a focused emphasis on learning outcomes and

digital pedagogy, offering deeper insights into the transformative potential of platforms like CAMPUS 2.0.

Despite its strengths, several limitations were identified during the research process. The educational focus that shaped the validation process primarily involved students, who are part of a digitally native generation and value interactive and dynamic platforms. While these gamification and interactive features effectively engage students, they may not fully meet the expectations of other user groups, such as teachers and staff, who prioritize stability and practical functionality. This difference in user needs resulted in varied feedback and highlights the challenge of balancing engagement and practicality across diverse audiences.

The study was also limited to a single university environment at PUJ, which constrains the generalizability of the findings. Other universities may have different infrastructure, educational models, or technological capabilities requiring adaptations to the platform. Broader validation across multiple institutions would be necessary to confirm the platform's wider applicability. Finally, the reliance on WordPress as the content management system and the use of certain plugins, while facilitating its implementation, imposed limitations on scalability and future development. Expanding interactive features, integrating augmented reality (AR) or virtual reality (VR), or enhancing functionalities may require revisiting the platform's technological foundation to ensure flexibility for future growth.

To address these limitations and improve CAMPUS 2.0, future versions should explore integrating emerging technologies, such as AR and VR, to increase user engagement and provide more interactive experiences. Improving interactivity through intuitive interfaces and real-time simulations could better meet student expectations and boost engagement. Customizing content to individual user needs with personalized profiles could increase relevance and satisfaction. Additionally, expanding the platform functionality to serve different educational contexts and user groups could broaden its impact and can help other universities leverage the principles and successes of CAMPUS 2.0 to enhance their own infrastructure management and educational practices.

Despite limitations, CAMPUS 2.0 stands as an innovative and usable tool for building information management within the university context. By focusing on building lifecycle, management, supply chain integration, and second design opportunities, the platform contributes to infrastructure management and supports educational and operational excellence. With future enhancements, it has the potential to drive both educational and operational innovation in university settings.

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References

1. Azhar, S. Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. *Leadersh. Manag. Eng.* **2011**, *11*, 241–252. [\[CrossRef\]](#)
2. Hajirasouli, A.; Banihashemi, S. Augmented reality in architecture and construction education: State of the field and opportunities. *Int. J. Educ. Technol. High. Educ.* **2022**, *19*, 1–28. [\[CrossRef\]](#)
3. Wu, Y.C.; Yang, J.C. The Effects of the Social Media-Based Activities and Gaming-Based Learning in Construction Education. In Proceedings of the 2015 IIAI 4th International Congress on Advanced Applied Informatics, IIAI-AAI 2015, Okayama, Japan, 12–16 July 2015; Institute of Electrical and Electronics Engineers Inc.: Piscatvey, NJ, USA, 2016; pp. 323–328. [\[CrossRef\]](#)
4. Yang, T.; Graca Gomes, J. Optimising Project Management Performance through Digital Supply Chain Management. 2023. pp. 63–77. Available online: <https://publications.ipma.world/wp-content/uploads/2023/12/5-RC2023.pdf> (accessed on 22 July 2024).
5. Salem, T.; Dragomir, M. Options for and Challenges of Employing Digital Twins in Construction Management. *Appl. Sci.* **2022**, *12*, 2928. [\[CrossRef\]](#)
6. Slaughter, E.S. Models of Construction Innovation. *J. Constr. Eng. Manag.* **1998**, *124*, 226–231. [\[CrossRef\]](#)
7. Norman, D. *Emotional Design: Why We Love (or Hate) Everyday Things*; Basic Books: Cambridge, UK, 2004.
8. Shojaei, R.S.; Oti-Sarpong, K.; Burgess, G. Enablers for the adoption and use of BIM in main contractor companies in the UK. *Eng. Constr. Archit. Manag.* **2023**, *30*, 1726–1745. [\[CrossRef\]](#)
9. Davies, A.; Lenfle, S.; Loch, C.H.; Midler, C. Introduction: Building bridges between innovation and project management research. In *Handbook on Innovation and Project Management*; Edward Elgar Publishing: Cheltenham, UK, 2023; pp. 1–34. [\[CrossRef\]](#)
10. Berardi, U. Clarifying the new interpretations of the concept of sustainable building. *Sustain. Cities Soc.* **2013**, *8*, 72–78. [\[CrossRef\]](#)
11. Omar, H.; Dulaimi, M. Solutions for effective diffusion of BIM for BIM late adopters: Case study of UAE AEC industry. *Int. J. Constr. Manag.* **2023**, *23*, 1484–1493. [\[CrossRef\]](#)
12. Loo, B.P.Y.; Wong, R.W.M. Towards a Conceptual Framework of Using Technology to Support Smart Construction: The Case of Modular Integrated Construction (MiC). *Buildings* **2023**, *13*, 372. [\[CrossRef\]](#)
13. Barbosa, F.; Woetzel, J.; Mischke, J. *Reinventing Construction: A Route to Higher Productivity*; McKinsey Global Institute: Brussels, Belgium, 2017.
14. Osman, A.M.; Liu, Y.; Wang, Z. Influence of Organizational Culture on Construction Firms' Performance: The Mediating Roles of Innovation and Marketing Capabilities. *Buildings* **2023**, *13*, 308. [\[CrossRef\]](#)
15. Sacks, R.; Eastman, C.; Lee, G.; Teicholz, P. *BIM Handbook*; Wiley: Hoboken, NJ, USA, 2018. [\[CrossRef\]](#)
16. Khosrowshahi, F.; Arayici, Y. Roadmap for implementation of BIM in the UK construction industry. *Eng. Constr. Archit. Manag.* **2012**, *19*, 610–635. [\[CrossRef\]](#)
17. Oke, A.; Kineber, A.; Albukhari, I.; Othman, I.; Kingsley, C. Assessment of Cloud Computing Success Factors for Sustainable Construction Industry: The Case of Nigeria. *Buildings* **2021**, *11*, 36. [\[CrossRef\]](#)
18. Tao, F.; Zhang, M.; Nee, A.Y. *Digital Twin Driven Smart Manufacturing*; Academic Press: Cambridge, MA, USA; Matthew Deans: London, UK, 2019.
19. Lavikka, R.; Kallio, J.; Casey, T.; Airaksinen, M. Digital disruption of the AEC industry: Technology-oriented scenarios for possible future development paths. *Constr. Manag. Econ.* **2018**, *36*, 635–650. [\[CrossRef\]](#)
20. Manzoor, B.; Othman, I.; Pomares, J.C. Digital technologies in the architecture, engineering and construction (Aec) industry—A bibliometric—Qualitative literature review of research activities. *Int. J. Environ. Res. Public Health* **2021**, *18*, 6135. [\[CrossRef\]](#) [\[PubMed\]](#)
21. Dosumu, O.S.; Mahame, C.; Niyitegeka, S.; Hahiiruwambaza, J.A. Applications and Challenges of Adopting the Internet of Things (IoT) in the Rwandan Construction Industry. *J. Constr. Dev. Ctries.* **2023**, *28*, 81–100. [\[CrossRef\]](#)
22. Yap, J.B.H.; Lee, K.P.H.; Skitmore, M.; Lew, Y.L.; Lee, W.P.; Lester, D. Predictors to Increase Safety Technology Adoption in Construction: An Exploratory Factor Analysis for Malaysia. *J. Civ. Eng. Manag.* **2023**, *29*, 157–170. [\[CrossRef\]](#)
23. Winter, J. Business Model Innovation in the German Industry: Case Studies from the Railway, Manufacturing and Construction Sectors. *J. Innov. Manag.* **2023**, *11*, 1–17. [\[CrossRef\]](#)
24. Hazarika, N.; Zhang, X. Factors that drive and sustain eco-innovation in the construction industry: The case of Hong Kong. *J. Clean. Prod.* **2019**, *238*, 117816. [\[CrossRef\]](#)
25. Porter, M.E.; Van Der Linde, C. Toward a New Conception of the Environment-Competitiveness Relationship. *J. Econ. Perspect.* **1995**, *9*, 97–118. [\[CrossRef\]](#)
26. Ullah, H.; Zhang, H.; Huang, B.; Gong, Y. BIM-Based Digital Construction Strategies to Evaluate Carbon Emissions in Green Prefabricated Buildings. *Buildings* **2024**, *14*, 1689. [\[CrossRef\]](#)
27. de Oliveira Faria, N.; Leeds, J.; Nadri, C.; Patrick, R.; Brown, W.; Gabbard, J.L.; Linares, D.A. Redefining a Campus Tour with Virtual Reality Virginia Tech Students Base Their Interactive Design on Survey Feedback. 2021. Available online: <https://www.iise.org/ISEmagazine> (accessed on 18 July 2024).
28. Wai, R.J. Systematic Design of Energy-Saving Action Plans for Taiwan Campus by Considering Economic Benefits and Actual Demands. *Energies* **2022**, *15*, 6530. [\[CrossRef\]](#)
29. Ye, X.; Jamonnak, S.; Van Zandt, S.; Newman, G.; Suermann, P. Developing campus digital twin using interactive visual analytics approach. *Front. Urban Rural. Plan.* **2024**, *2*, 9. [\[CrossRef\]](#)

30. Valbuena-Bermúdez, C.; Lozano-Ramírez, N.E.; Serrano-Sierra, A.; Granados-León, C. CAMPUS: A mobile app for construction processes learning and teaching in higher education. *Comput. Appl. Eng. Educ.* **2024**, *32*, e22739. [CrossRef]
31. WordPress. WordPress.com: Build a Site, Sell Your Stuff, Start a Blog & More. Available online: <https://wordpress.com/> (accessed on 16 July 2024).
32. WPForms. WPForms—Easy Form Builder for WordPress—Contact Forms, Payment Forms, Surveys, & More—WordPress plugin | WordPress.org. Available online: <https://wordpress.org/plugins/wpforms-lite/> (accessed on 16 July 2024).
33. AYS Pro Plugins. Quiz Maker—WordPress Plugin | WordPress.org Corsu. Available online: <https://co.wordpress.org/plugins/quiz-maker/> (accessed on 16 July 2024).
34. Heigl, A. AuthLdap—WordPress Plugin | WordPress.org. Available online: <https://wordpress.org/plugins/authldap/> (accessed on 16 July 2024).
35. Loginizer. Loginizer—WordPress Plugin | WordPress.org. Available online: <https://co.wordpress.org/plugins/loginizer/> (accessed on 16 July 2024).
36. Plugins & Snippets. Simple Page Access Restriction—WordPress Plugin | WordPress.org. Available online: <https://wordpress.org/plugins/simple-page-access-restriction/> (accessed on 16 July 2024).
37. WPForms. WP Mail SMTP by WPForms—The Most Popular SMTP and Email Log Plugin—WordPress Plugin | WordPress.org. Available online: <https://wordpress.org/plugins/wp-mail-smtp/> (accessed on 16 July 2024).
38. Osgood, C.E.; Suci, G.J.; Tannenbaum, P.H. The Measurement of Meaning. *Language* **1957**, *35*, 58. [CrossRef]
39. Hsu, S.; Chuang, M.; Chang, C. A semantic differential study of designers' and users' product form perception. *Int. J. Ind. Ergon.* **2000**, *25*, 375–391. Available online: <https://www.sciencedirect.com/science/article/pii/S0169814199000268> (accessed on 16 September 2024). [CrossRef]
40. Huang, Y.; Chen, C.; Khoo, L. Products classification in emotional design using a basic-emotion based semantic differential method. *Int. J. Ind. Ergon.* **2012**, *42*, 569–580. Available online: <https://www.sciencedirect.com/science/article/pii/S016981411200087X> (accessed on 16 September 2024). [CrossRef]
41. Lin, R. Application of the semantic differential to icon design. *Proc. Hum. Factors Soc.* **1992**, *1*, 336–340. [CrossRef]
42. Macedo, V.; Silva, C.M. Building a Semantic Differential Scale as Tool for Assisting UX Evaluation with Home Appliances. In *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*; Springer: Berlin/Heidelberg, Germany, 2014; Volume 8517, pp. 308–317. [CrossRef]
43. Brühlmann, F.; Director, R.; Petralito, S.; Rieser, D.C.; Aeschbach, L.F.; Opwis, K. TrustDiff: Development and Validation of a Semantic Differential for User Trust on the Web. *J. Usability Stud.* **2020**, *16*, 29–48. Available online: https://uxpajournal.org/wp-content/uploads/sites/7/pdf/JUS_Bruhlmann_Nov2020.pdf (accessed on 16 September 2024).
44. Morville, P.; Callender, J. Search Patterns: Design for Discovery. 2010. Available online: https://books.google.com/books?hl=es&lr=&id=LzgNHuKKGJIC&oi=fnd&pg=PR9&dq=peter+morville+honeycomb&ots=sDa-AYLzYL&sig=hxsVcaChMJ-mZYFsLKwiaQ_bf8U (accessed on 12 September 2024).

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