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RESEARCH PAPER

Beyond Navigation: Understanding Semantic Gaps in the Information Architecture of a University Portal

Más allá de la navegación: comprendiendo las brechas semánticas en la arquitectura de información de un portal universitario

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Abstract

University portals serve as primary access points to academic, administrative, and communication services in higher education. However, their usability and information architecture often fail to align with users' expectations, resulting in inefficiencies and cognitive overload. This study presents an empirical validation of the web portal of the University of Colima, focusing on the evaluation of its information architecture through a tree testing approach. The experiment involved nine representative user profiles (including students, faculty, administrative staff, and external visitors) to assess navigation efficiency, semantic consistency, and success rates across realistic information-seeking tasks. Overall results indicated moderate usability performance: while users achieved success rates above 80% for routine tasks, those requiring interpretation of institutional terminology showed considerably lower outcomes. Excessive hierarchical depth and ambiguous labeling emerged as primary barriers to efficient navigation. Cross-group analysis revealed notable differences among users, particularly between experienced institutional members and new or external visitors, highlighting the need for more inclusive and adaptive design strategies. The findings support simplifying the portal's information hierarchy, standardizing terminology, and integrating iterative usability testing as part of continuous improvement. This work contributes to the growing body of research on university website usability and offers an evidence-based framework for designing user-centered information architectures in higher education.

Keywords:

Information architecture; usability evaluation; university web portal; tree testing; user-centered design; higher education.

Resumen

Los portales universitarios funcionan como puntos de acceso primarios a los servicios académicos, administrativos y de comunicación en la educación superior. Sin embargo, su usabilidad y arquitectura de información con frecuencia no se alinean con las expectativas de los usuarios, generando ineficiencias y sobrecarga cognitiva. Este estudio presenta una validación empírica del portal institucional rediseñado de la Universidad de Colima, centrada en la evaluación de su arquitectura de información mediante la técnica de *tree testing*. El experimento involucró nueve perfiles representativos de usuarios (entre ellos estudiantes, profesorado, personal administrativo y visitantes externos) para analizar la eficiencia de navegación, la coherencia semántica y las tasas de éxito en tareas de búsqueda de información realistas. Los resultados mostraron un desempeño de usabilidad moderado: aunque los usuarios alcanzaron tasas de éxito superiores al 80 % en tareas rutinarias, aquellas que requerían interpretar terminología institucional obtuvieron resultados considerablemente menores. La profundidad excesiva de los menús y la ambigüedad de las etiquetas surgieron como las principales barreras para una navegación eficiente. El análisis entre grupos reveló diferencias notables entre usuarios con experiencia institucional y visitantes nuevos o externos, lo que evidencia la necesidad de estrategias de diseño más inclusivas y adaptativas. Los hallazgos respaldan la simplificación de la jerarquía informativa, la estandarización de la nomenclatura y la incorporación de pruebas de usabilidad iterativas como parte del proceso de mejora continua. Este trabajo contribuye al creciente cuerpo de investigación sobre la usabilidad de sitios web universitarios y ofrece un marco basado en evidencia para el diseño de arquitecturas de información centradas en las personas en el ámbito de la educación superior.

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Palabras clave:
Arquitectura de la información; evaluación de usabilidad; portal web universitario; prueba de árbol; diseño centrado en el usuario; educación superior.

1 Introduction

In modern higher education, an institutional portal or university website serves as the primary gateway to a university's digital services and information. It is often considered the digital "face" of the institution, representing its identity, culture, and values to the world [3]. Over the past decade, universities have undergone a paradigm shift toward delivering many academic and administrative services online [1]. Students and staff can now access enrollment systems, course resources, campus news, and a myriad of e-services through a few clicks on the university portal [1]. This central role means that the portal's usability and information organization are critical – a well-designed portal enables users to efficiently find what they need, whereas a poorly designed one can impede access to important services and information.

Usability and information architecture (IA) have thus become focal points in the design of educational websites. Information architecture refers to the art and science of organizing and labeling website content to support findability and understanding [10]. In practical terms, the portal's menu structure, navigation paths, and category nomenclature should align with users' expectations to help them understand where they are and how to get to what they want [10]. Research emphasizes that an intuitive structure ensures users can easily access required services, enhancing their overall user experience, while a poorly organized layout can deter users and undermine the adoption of those e-services [10]. After the COVID-19 pandemic, when universities expanded online offerings, these factors have become even more crucial: diverse users (from tech-savvy students to external visitors) now rely on the website as a first-stop for information, so the portal's information architecture must accommodate different user tasks and needs [10]. In short, good IA and usability are not just web design niceties – they are essential for ensuring all users can navigate the site efficiently and have a satisfying experience.

Reflecting this importance, numerous studies between 2010 and 2025 have evaluated university website usability and identified common pain points. Globally, universities recognize that their websites showcase institutional identity and influence reputation. A recent systematic review research found active web usability efforts in 24 countries (and across Latin America as a region), all aiming to pinpoint obstacles and improvements for university websites [16]. Despite this attention, many university portals still suffer from usability issues. For example, one case study using eye-tracking on a university portal revealed that students often spend excessive time scanning the homepage for the right link, and a surprisingly large number had never used certain online services at all, likely due to confusion or poor design [1]. These usability problems (whether confusing menus, unclear labels, or disorganized content) can prevent users from taking full advantage of the available digital services [1]. Broader evaluations echo these findings: in one comparative assessment of 86 university websites, researchers found that most sites failed to meet basic usability standards expected by students [16]. Common issues include hard-to-find information, non-intuitive navigation flows, and inconsistent terminology, which together undermine user efficiency and satisfaction. In many cases, the criteria for good educational website design have been poorly understood by developers, leading to sites that do not fully align with student needs [16]. Such shortcomings have consequences, as frustrated users may abandon the online portal, reverting to offline processes or seeking information through unofficial channels, which negates the purpose of a digital gateway.

Conversely, improving the usability and information architecture of a university portal can yield significant benefits. Studies have shown that all major dimensions of website usability (from navigation and interface design to content organization) positively affect user satisfaction [3]. In particular, the clarity, organization, and currency of content have the strongest influence on students' satisfaction with a university website [3]. When information is well-structured and labeled in a way that makes sense to users, they can complete tasks faster and with less frustration, leading to a more positive perception of the site (and by extension, the institution). Indeed, an effective, up-to-date university website is seen not only as a convenience but as an asset to the institution's image. Prior research has highlighted that continuously improving a university's web usability is vital for sustaining its reputation and even competitive ranking [16]. In other words, the university portal is more than just an IT tool – it is part of the university's service quality and brand, affecting how current and prospective students perceive the institution. For these reasons, many universities worldwide (including in Latin America) have invested in usability evaluations and iterative redesigns of their web portals [16], seeking to align their information architecture with user expectations and best practices in user experience.

Building on this theoretical and practical foundation, this research positions itself at the intersection of usability evaluation and information architecture validation within higher education. While numerous studies have explored university website usability from general or comparative perspectives, few have systematically validated a redesigned portal through empirical user testing that considers multiple institutional roles and user profiles. The present work addresses this gap by conducting a comprehensive evaluation of the Universidad de Colima (UdeC) institutional website redesign. The study is grounded in evidence-based methods and adopts a user-centered approach to ensure that structural and linguistic changes in the new information architecture effectively improve user experience across diverse audiences.

1.1 Research Contributions

This study makes three primary contributions to the field of Human–Computer Interaction and educational web usability research:

- **Empirical validation of a complex information architecture through real user behavior**: The research implements tree testing as a structured method to assess the efficiency of the proposed navigation schema. This enables a data-driven analysis of how users from various academic and administrative backgrounds find key information and complete representative tasks within the new structure.
- **Identification of critical design and nomenclature challenges in a university portal context**: By observing users' decision paths and points of confusion, the study reveals semantic and structural mismatches between the designers' conceptual model and users' mental models. These insights contribute to understanding how institutional terminology and hierarchy affect navigation and findability.

- **Actionable recommendations for user-centered redesign and continuous improvement**: Based on quantitative performance metrics and qualitative feedback, the paper provides concrete design guidelines for improving ease of access, clarity, and efficiency in university-level digital ecosystems. These recommendations extend beyond UdeC, offering a transferable framework for similar higher education institutions seeking to enhance their web usability and information architecture.

Through these contributions, the research aims to ensure that the redesigned UdeC portal not only reflects institutional identity but also delivers an intuitive, efficient, and inclusive digital experience. The following sections detail the methodology employed for usability testing, the results derived from multi-profile user evaluations, and the implications for refining information architecture in academic web environments.

2 Methods

The study employed an empirical, user-centered approach to evaluate the efficiency and clarity of the proposed information architecture for the redesigned institutional website of the University of Colima (UdeC). The evaluation followed the tree testing method, a standard usability technique used to assess how well users can locate information in a hierarchical structure without the influence of visual design or interface elements. The testing was conducted using the Treejack tool from Optimal Workshop, which allows researchers to model navigation trees and analyze participants' paths, completion times, and success rates.

2.1 Procedure Overview

The methodological process was designed to systematically validate the proposed portal architecture under controlled yet realistic conditions (see Figure 1). The first stage consisted of translating the conceptual structure of the redesigned website into a fully functional tree model in Treejack. This step ensured that all levels of hierarchy, categories, and subcategories represented the architecture's intended information flow, with labels identical to those proposed by the design team. By testing this structure before implementation, the research aimed to identify usability barriers early, minimizing costly redesigns during development.

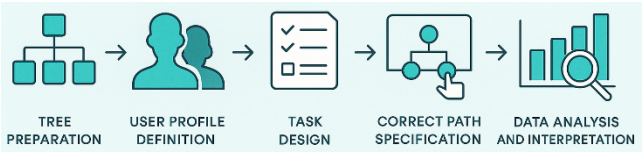

Figure 1. Tree testing workflow.

The second stage involved identifying and defining representative user profiles. Because a university portal serves a highly heterogeneous audience—ranging from students and faculty to administrative staff and external visitors—the inclusion of diverse participants was essential to ensure generalizability. The third stage focused on constructing realistic information-seeking tasks for each profile. These tasks were grounded in actual user needs, ensuring that every task corresponded to authentic goals users would pursue in the real portal environment.

The fourth stage involved defining expected correct navigation routes for each task, thereby providing a baseline for quantitative comparison between ideal and actual user behavior. In the fifth stage, usability tests were conducted in controlled sessions using the Treejack platform, during which participants independently completed the assigned tasks. Finally, in the sixth stage, the collected data were analyzed both quantitatively—using success and error metrics—and qualitatively—by reviewing navigation patterns and user comments. The combination of both approaches provided a comprehensive understanding of how users interacted with the proposed structure and where improvements were required.

This multi-stage methodology was selected for its ability to reveal discrepancies between designers' assumptions about information organization and users' mental models, which are critical to the success of any web information architecture.

2.2 Preparation of the Navigation Tree

The new information architecture proposed for the UdeC institutional portal was transposed into a hierarchical tree structure with up to six levels of depth, faithfully replicating the intended organization of the website's menus and submenus (see Figure 2). This digital representation served as the experimental environment in Treejack, allowing participants to navigate purely through text-based menus.

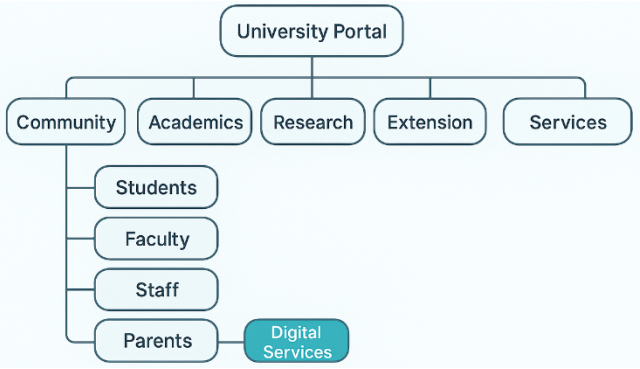

Figure 2. Fragment of the proposed information architecture.

The absence of visual design elements (such as color, typography, or layout) ensured that users' decisions were influenced solely by the logic of categorization and the clarity of terminology. This method is widely used in information architecture research because it isolates cognitive navigation processes from aesthetic biases, providing insight into whether users intuitively understand the hierarchy and naming conventions of menu options. The resulting model thus enabled an accurate assessment of findability, one of the core attributes of usable web systems.

2.3 User Profiles

Participants were selected to represent the main user groups of the institutional portal: high school students, undergraduate students, graduate students, full-time faculty, adjunct faculty, secretarial staff, administrative staff, university officials, and parents of students. Each group corresponds to a distinct role within the university ecosystem, with specific informational needs, terminology familiarity, and patterns of interaction with institutional digital services.

Including this diversity of participants was critical to ensuring that the redesigned portal would meet the expectations of its varied audiences. For instance, high school students (many of whom are minors) tend to search for academic calendars, scholarships, and admission-related resources, while graduate students are more

interested in exploring research databases, course plans, and information about funding opportunities. Faculty members often seek teaching support tools, directories, and institutional policies, whereas administrative and secretarial staff prioritize internal regulations, official documents, and communication channels. University officials and parents, on the other hand, require high-level access to organizational and financial information.

Recruiting participants from across these categories allowed the research team to analyze not only task completion success but also the semantic congruence between menu labels and user expectations. Differences in domain knowledge, vocabulary, and prior experience with institutional systems often lead to variations in how users interpret category names, making this multi-profile sampling essential for detecting inconsistencies in the IA.

Although participation numbers varied by group depending on volunteer availability, the overall composition ensured representation from all nine profiles (see Table 1), offering a realistic view of how diverse user groups interact with the university's information infrastructure.

Table 1. Participant profiles and sample distribution.

User profile	n	Typical information goals	Testing environment
High school students	10	Academic calendar, scholarships	In-person
Undergraduate students	13	Course schedules, forms	In-person
Graduate students	11	Research resources, workshops	In-person
Faculty (full-time/hourly)	15	Institutional news, HR policies	In-person
Secretarial/Admin staff	24	Internal procedures, regulations	In-person
Officials	3	Reports, budgets, planning	In-person
Parents	2	Tuition info, contact directories	In-person

2.4 Task Design

The construction of the navigation tasks was informed by the findings of the "ESP 2021 Analysis Institutional Web Portal (Advances)" report [12], an extensive diagnostic study conducted by the University of Colima involving 4,468 students, 792 faculty members, and 368 administrative staff across all academic levels and campuses. This large-scale evaluation provided empirical insights into how users from different university sectors perceived and interacted with the institutional portal, and what types of content and functionalities they most frequently sought.

The report revealed that, although general satisfaction with the portal was moderate, the penetration and reach of information were limited, suggesting that users struggled to locate relevant content despite its availability. Two overarching dimensions were identified as requiring improvement: (1) the navigation experience, including visual design, ease of access, and visibility of relevant information, and (2) content organization, particularly in academic information, campus updates, and access to digital services.

To ground the usability test in authentic user needs, the present study extracted key categories from the prior survey and transformed them into realistic, goal-oriented navigation scenarios. For instance, students had emphasized the need for easier access to scholarship information (176 mentions), academic calendars and events (163), digital academic resources (143), and cultural or sports offerings (117).

These empirically derived categories were translated into specific test tasks, for example, locating the requirements for scholarship applications, finding upcoming events in a given faculty, or accessing internal regulations. Each task was designed to reflect a meaningful real-world action that a user would likely perform within the redesigned portal. By operationalizing the survey's categories as usability test items, the study ensured that its evaluation directly addressed previously identified pain points rather than hypothetical ones.

Additionally, qualitative feedback from the report was used to refine task phrasing. Participants in that earlier study had frequently recommended improving information organization, updating frequency, and assistance for information search. In response, the present IA test included tasks that probed these very dimensions (such as finding recently updated academic news or identifying where to seek help for technical issues) to assess whether the new information architecture effectively resolved prior frustrations.

This evidence-driven task design provided methodological continuity between diagnostic and evaluative stages of the portal's redevelopment. In this way, the usability testing not only measured the functional performance of the proposed information architecture but also validated whether the redesign succeeded in addressing user expectations empirically documented in the survey.

2.5 Specification of Correct Paths

For every task, the research team defined one or more expected correct navigation routes within the hierarchical structure, corresponding to the ideal paths users should follow to reach the intended information. These predefined routes served as the reference framework for analyzing success rates and error patterns.

For instance, to locate the requirements for requesting a copy of a high-school certificate, two valid paths existed within the proposed structure (translated from the original in Spanish):

1. *#UdeCCommunity → Student → Electronic Services,* and
2. *#UdeCCommunity → Student → High School → Procedures*.

The existence of multiple valid paths reflected the flexibility of the design and acknowledged that users might conceptualize information differently (see Figure 3).

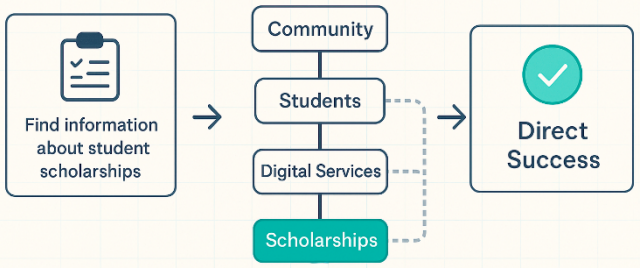

Figure 3. Example of correct navigation paths.

This step was critical for distinguishing between design flaws and individual user variability. When participants reached the correct endpoint through an alternative but semantically reasonable route, the result was classified as indirect success, providing

evidence of partial structural robustness in the information architecture.

2.6 Usability Test Execution

The usability sessions were conducted in person in a university laboratory. Prior to participation, the purpose of the study was explained, and participants were grouped by profile. Each group participated in sessions tailored to their user profile. Participants accessed the Treejack interface via individualized links and completed the assigned set of tasks at their own pace, without assistance or external guidance.

The test followed a "blind" IA-only approach: participants interacted exclusively with a text-based navigation tree, without any visual cues, icons, page layouts, colors, or institutional styling. This setup ensured that all decisions reflected semantic interpretation and cognitive expectations rather than interface affordances.

This minimalist configuration was deliberate, as it ensured that observed difficulties stemmed from information architecture issues rather than visual or interaction design factors. The environment allowed researchers to record precise metrics such as task duration, path length, and selection sequences while maintaining a low-cognitive-load context.

Figure 4 shows a representative excerpt of the hierarchical structure used in Treejack, illustrating the navigation depth and labeling scheme presented to participants during the blind information-architecture evaluation.

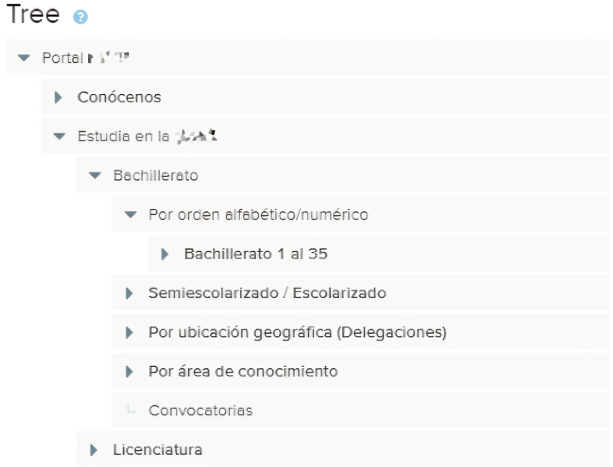

Figure 4. Representative fragment of the portal tree used in the Treejack study.

2.7 Data Treatment and Analysis

Data were automatically collected through Treejack and analyzed using Optimal Workshop's built-in analytics dashboard. Each task outcome was classified into one of six result categories:

- **Direct success**: The user selected the correct option without exploring other paths.
- **Indirect success**: The user navigated through multiple menus before selecting the correct option.
- **Direct failure**: The user chose an incorrect option immediately, without exploring alternatives.
- **Indirect failure**: The user explored multiple paths but ultimately chose an incorrect option.
- **Direct skip**: The user skipped the task without any navigation.
- **Indirect skip**: The user explored the structure but did not select an answer.

The analysis combined these categories to calculate overall task success rates, error rates, and omission frequencies.

A success rate of 80% or higher was established as the benchmark for acceptable performance, following common usability testing conventions. Tasks falling below this threshold were flagged for further examination to determine whether their labels, hierarchy, or categorization contributed to user confusion.

To complement the quantitative findings, the researchers qualitatively analyzed navigation trails (sequences of menu selections recorded by Treejack) to identify recurrent patterns and problematic nodes. For instance, frequent backtracking or prolonged dwell time within certain menu branches suggested semantic ambiguity or suboptimal grouping of information. These insights informed a set of recommendations for restructuring and renaming specific sections to improve clarity and ease of access.

2.8 Ethical Considerations

All procedures adhered to the ethical standards established by the University of Colima for research involving human participants. Participation was voluntary, anonymous, and non-incentivized. No personally identifiable data was collected, and all responses were treated confidentially. Written informed consent was obtained from all participants. For minors, parental consent was secured

This methodological approach combined quantitative performance metrics with qualitative interpretive analysis to provide a comprehensive validation of the proposed portal architecture. By applying the tree testing method across nine representative user profiles, the study ensured that its findings reflect the actual information-seeking behavior of the university community.

The next section presents the results of this evaluation, detailing success rates, navigation patterns, and user insights that highlight both strengths and improvement opportunities within the institutional website's structure.

3 Results

The results of the usability evaluation are presented by user profile, emphasizing quantitative task success rates and qualitative observations related to users' navigation behavior, terminology interpretation, and overall task performance. The findings highlight how different audiences perceived and interacted with the proposed information architecture, providing a comprehensive understanding of its effectiveness and areas requiring refinement.

3.1 General Overview

Across all profiles, the results revealed that participants were generally able to navigate the proposed portal structure but encountered recurrent challenges related to menu depth, label clarity, and conceptual alignment between institutional terminology and user expectations. Terminology mismatches repeatedly surfaced across profiles: high-school students, for instance, treated "Servicios electrónicos" and "Herramientas digitales" as interchangeable, even though the portal separated them; likewise, the label "Extensión" was meaningful only to internal staff, with nine out of ten participants failing to link it to cultural or community services. These cases highlight a clear semantic gap between institutional jargon and users' natural vocabulary. While some user groups achieved high levels of direct success in routine tasks, others required multiple navigational steps, suggesting a mismatch between the site's organizational logic and users' mental models.

An overall success rate of 80% was adopted as the threshold for satisfactory performance. Tasks that fell below this benchmark were considered indicators of potential usability or information architecture issues. Several tasks across multiple profiles yielded results below this level, particularly those requiring the identification of psychological services, the reporting of gender-based violence, and access to administrative procedures.

Another cross-cutting finding concerned the excessive hierarchical depth of the navigation tree. The six-level structure often forced users to perform more clicks than necessary, extending completion times and increasing cognitive effort. Participants' comments reinforced this observation, as many expressed frustrations about the number of intermediate menus they had to explore before locating the desired information. This pattern is clearly illustrated in Figure 5, which shows a representative navigation path containing multiple micro-loops and repeated backtracking.

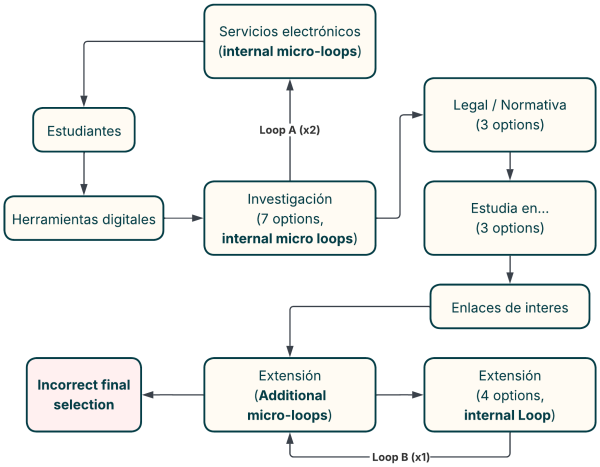

Figure 5. Real navigation path from a participant, illustrating internal micro-loops, backtracking, and depth exploration.

A brief benchmarking of well-established university portals included in the institutional report reinforces these patterns. Sites such as Stanford and Carleton adopt intentionally shallow hierarchies, UDLAP highlights role-directed shortcuts, and Universidad Veracruzana uses clear, culturally meaningful labeling. Together, these examples align with our findings and support the recommendation to reduce menu depth and standardize terminology.

Figure 6 summarizes task-level performance for one representative user profile, illustrating the distribution of direct and indirect success and failure across the seven tasks.

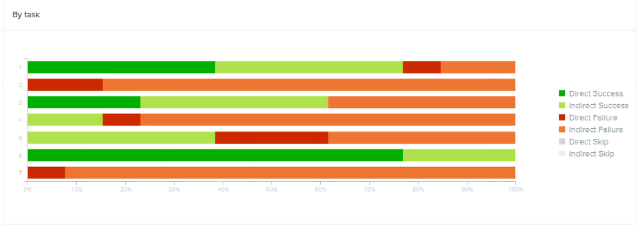

Figure 6. Task-level performance for one user profile, showing direct/indirect success and failure across the seven tasks.

3.2 High School Students

Ten participants representing high school students completed eight tasks designed to simulate typical academic and administrative searches. Overall, this group achieved moderate success rates, particularly in tasks involving academic calendars and event information. However, performance decreased substantially in tasks that relied on institutional terminology unfamiliar to younger users.

For instance, only a small fraction of participants correctly located the cultural agenda ("Contempo & something else"), as most expected to find such events under "Student Life" or "Calendar" rather than within the "Extension" section. This discrepancy underscores a semantic gap: while "extension" is an institutional term used internally, it lacked immediate meaning for students.

Similarly, confusion arose between the labels "Electronic services" and "Digital tools." Participants assumed that both referred to different categories, despite the fact that they contained overlapping content, such as access to the LMS university platform. Several students suggested consolidating these into a single, more intuitive label.

Another recurrent issue involved the task "Download the format to report gender violence." Some students attempted to find this information on their school's individual website rather than within the institutional hierarchy, revealing a fragmented mental model of where administrative forms should reside.

Qualitative feedback from this group emphasized the desire for direct access to key items such as scholarship forms, faculty contacts, and event calendars. Students expressed that the number of menus required to reach basic information could discourage them from using the portal altogether.

3.3 Undergraduate Students

Thirteen undergraduate students completed seven tasks, yielding mixed results. They performed well in procedural searches, such as obtaining a copy of a high-school certificate or consulting academic calendars, yet struggled with tasks involving mental health resources and contact directories.

The task "Find information about psychological counseling" produced a 0% direct success rate. Participants navigated extensively through unrelated menus (such as "Community," "Student Services," and "Academic Support") without locating the correct option. Average completion time for this task exceeded eight minutes, the highest among all profiles, demonstrating both structural and labeling issues.

Furthermore, the task "Consult contact details of faculty and administrative personnel" also resulted in low success rates. Participants expected to find this information in a section labeled "Directory," yet the directory was buried within each faculty's subpage, and some of those sections lacked visible contact information altogether.

Participants' written comments echoed the need for better organization and fewer hierarchical levels. Many proposed integrating course schedules, scholarship information, and mental health resources within a personalized portfolio reachable from the main student section. These suggestions align with best practices in portal personalization and role-based access design.

3.4 Graduate Students

Eleven graduate students participated in nine tasks focused on research resources, academic services, and institutional support. Their overall performance was moderate but highlighted systemic issues in content grouping.

A recurrent error occurred in the task "Explore a scientific journal through the virtual library." Nearly half of the participants attempted to find this under "Research" instead of "Library," implying that the taxonomy did not align with how advanced users conceptualize research-related resources. The report recommended adding a subcategory titled "Resources for your research" under "Research" to address this expectation.

Graduate students also struggled to locate workshops and extracurricular courses, often confusing "Education Continuum" with "Extension." This reinforces the earlier observation that institutional terminology needs simplification and clearer definitions.

Qualitative comments from this group further emphasized the need for improved search functionality and categorization. Several participants noted that the site's internal search tool failed to yield comprehensive results, limiting their ability to find relevant materials.

3.5 Faculty Members

Two categories of faculty were considered: nine full-time professors and six adjunct (hourly) professors. Both groups displayed similar navigation patterns and error types, often mirroring those observed among students but influenced by professional responsibilities.

Both faculty groups encountered difficulties locating psychological support information and incident reporting forms. Many participants expected these resources to appear in highly visible areas, such as the homepage or within the "Human Resources" section, instead of under nested community menus. Professors also reported difficulty in finding institutional news, events, and research-related content, often due to ambiguous menu labels and redundant categories.

Notably, several faculty members commented that the menu structure closely resembled the previous version of the portal, which they already perceived as inefficient. This observation suggests that incremental modifications to an existing hierarchy may be insufficient; instead, a conceptual reorganization based on user workflows and content semantics may be required.

3.6 Secretarial and Administrative Staff

The secretarial (10 participants) and administrative (14 participants) groups exhibited similar patterns of success and failure. They completed straightforward tasks (such as accessing institutional news or internal regulations) relatively efficiently but encountered challenges in retrieving forms for economic leave or administrative procedures. These difficulties stemmed primarily from the inconsistent use of terms and the dispersion of related services across multiple submenus.

The task "Consult information to request an economic leave" exemplified this issue: participants often navigated to "Human Resources" or "Services," expecting to find the form there, only to discover it was located under "Community → Staff → Procedures." This inconsistency led to redundant navigation and user frustration.

Participants also highlighted the lack of clear differentiation between "Administrative," "Secretarial," and "Staff" subcategories. They proposed integrating these under a single "Employees" or "Personnel" section to simplify access paths and reduce cognitive overhead.

3.7 University Officials

Three university officials participated in the evaluation, focusing on strategic and administrative content such as policies, financial reports, and institutional branding. Although the small number of participants limits generalization, the findings from this profile were nonetheless significant.

Officials successfully completed most governance-related tasks, but expressed dissatisfaction with the depth of navigation required to locate essential documents. For instance, locating the first quarter budget report for the PROFEXCE program required navigating multiple levels, as some participants initially searched under "Transparency" instead of "Planning." This suggests that the conceptual mapping of financial information needs reorganization to align with organizational logic rather than administrative structure.

They also noted that the university directory and privacy policy should be reachable directly from the main page, emphasizing visibility and accountability.

3.8 Parents of Students

The smallest group, consisting of two parent participants, encountered significant challenges in completing their three assigned tasks. They failed to locate the contact information for the director of a faculty, misinterpreted "Community" as an internal section, and could not identify where tuition or program cost information was published.

These results reveal a critical accessibility gap for external users. Parents, who may not be familiar with university jargon or internal structures, represent a stakeholder group that requires simplified navigation and plain-language terminology. Their performance underscores the importance of designing inclusive information architectures that accommodate not only institutional insiders but also external audiences.

3.9 Cross-Profile Patterns and Observations

When comparing results across all nine profiles, several consistent patterns emerged. First, terminology and information labeling significantly influenced navigation efficiency. Some terms, such as the previously mentioned "Electronic services" and "Digital tools," were recurrent sources of confusion across nearly all user groups. Second, the excessive hierarchical depth of menus increased completion times and error rates. The report recommended limiting navigation depth to a maximum of three levels to reduce cognitive load and improve visibility of options.

Third, high-demand sections such as the academic calendar, scholarships, and directory required too many steps to reach the destination. The study proposed making these elements reachable directly from the homepage or through personalized dashboards. Finally, feedback consistently highlighted the need for a global search function and better integration of faculty-specific websites, as fragmented sub-portals contributed to disorientation.

Overall, the results demonstrated that while the proposed information architecture improved some aspects of organization and coherence compared to the existing portal, several design and semantic issues persisted (see Table 2). The findings provide empirical evidence supporting a series of recommendations for restructuring content categories, simplifying menu hierarchies, and harmonizing terminology.

Figure 7 provides a cross-profile comparison of success rates and mean completion times, highlighting how different user groups performed relative to the 80% usability benchmark.

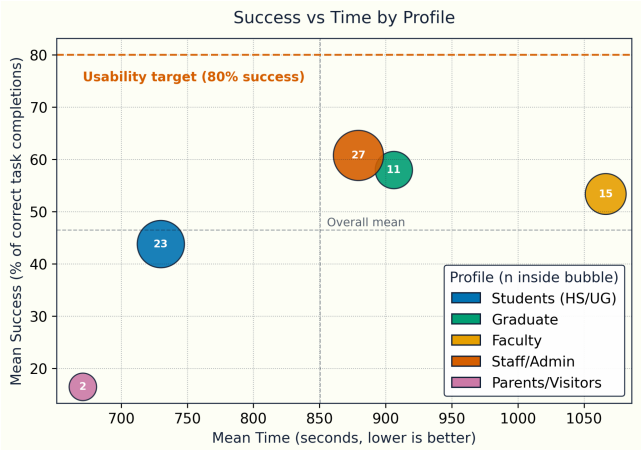

Figure 7. Cross-profile comparison of mean success rates and completion times (bubble size indicates profile sample size).

Table 2. Summary of task performance by profile.

Profile	Mean Success (%)	Mean Time (s)	Main Difficulties
Students (HS/UG)	72	260	Ambiguous terms ("Extension")
Graduate	80	210	Misplaced "Library" content
Faculty	78	240	Confusion between "Electronic services" VS. "Digital tools"
Staff/Admin	82	190	Redundant menu structure
Parents/Visitors	55	300	Misinterpretation of "Community"

The next section discusses these findings in the context of information architecture and usability research, drawing connections to broader principles of web design in higher education and outlining actionable guidelines for enhancing the University of Colima's institutional portal.

4 Discussion

The findings of the UdeC portal tree test align with and add nuance to global research on information architecture (IA) in higher education websites. Issues of labeling clarity, user expectations, navigation depth, and semantic organization observed at UdeC echo challenges reported in international studies. Below, we contrast our results with key insights from the literature.

4.1 Labeling Clarity and User Vocabulary

UdeC's users struggled with internal jargon (e.g., Extension) and duplicate labels (Digital labels vs Electronic services), indicating a semantic misalignment between site structure and user mental models. This mirrors common issues in academic websites: for example, Sabariah et al. noted that students "*find it hard to navigate…due to inappropriate menu layout and unfamiliar usage*" of terms [9]. International best practices emphasize using user-centered labels over institutional terminology to improve findability. Consistent with UdeC's experience, involving actual users in IA design (e.g., via card sorting) often reveals confusing labels and significantly boosts usability. In this study, the redesigned university site's usability score improved to ~71% once labels and categories were aligned to user expectations [9].

4.2 User Expectations and Mental Models

The UdeC test revealed that users frequently sought information in locations that aligned with their expectations, rather than adhering to the official site hierarchy (e.g., expecting scholarship information under faculty pages). Such behavior underscores the importance of matching IA to users' mental models. Prior studies confirm that different user groups can conceptualize information differently. Wentzel et al. found that a navigation scheme derived from one user group's card sort did not generalize well to another group, even within the same domain [14]. This suggests that an IA structured purely around an organization's internal logic (or a single user profile) may fail other audiences, a challenge UdeC also identified with its heterogeneous audience (students, faculty, parents, etc.). Comparative evaluations in healthcare and government domains likewise stress iterative IA validation to ensure the structure makes sense to diverse users.

4.3 Hierarchical Depth and Navigation Structure

UdeC's recommendation to reduce the menu hierarchy to at most 3 levels reflects a broader consensus that overly deep navigation impedes usability. Deeply nested menus require many clicks and complicate wayfinding, an issue documented in both corporate and public-sector sites. Bodrunova and Yakunin observed that for complex tasks, menu complexity (e.g., greater path depth) led users to adopt chaotic search strategies and reported significantly higher difficulty [2]. University websites have thus moved toward broader, shallower IA designs; for example, Stanford and Carleton University portals present second-level options on dedicated landing pages instead of burying content under multiple submenus [1, 2, 6]. This flatter structure aligns with UdeC's findings that a shallower hierarchy better meets user expectations of quick access to key content.

4.4 Semantic Grouping and Cross-Listing of Content

The tree test analysis at UdeC highlighted instances where content would benefit from being reachable via multiple paths [13]. For instance, students expected certain items (like mobility scholarship calls) under student-life sections as well as under a centralized "Scholarships" section. This points to a need for flexible, user-centric categorization. Other IA studies have similarly noted that rigid single-hierarchy structures can fail when content logically belongs to more than one category [7, 8]. Incorporating cross-linking or polyhierarchical organization (e.g., linking "Scholarships" from both financial aid and student opportunities pages) is emerging as a best practice to improve semantic fit and meet varied user expectations.

4.5 Value of IA Validation Pre-redesign

UdeC's use of Treejack in a pre-visual redesign phase exemplifies the proactive approach advocated in UX research. Early IA validation enables designers to address structural and labeling issues before investing in visual design and development. Tapia et al. emphasize that tree testing is a useful, practical method that should be applied in the early stages of projects, as doing so catches

navigation errors that might otherwise surface only in later usability tests or not at all [11]. Indeed, tree testing (sometimes called reverse card sorting) has become an established technique in industry for vetting category structures [4]. Studies report that a combination of card sorting (to generate a user-informed IA) followed by tree testing (to validate it) constitutes a global best practice for user-centered IA design in higher education and beyond [5, 15]. By validating the portal's architecture upfront, UdeC's case illustrates the broader benefit of IA-focused UX research: it ensures that when a visual redesign is eventually implemented, it rests on a solid, evidence-based structural foundation, thereby aligning the site with both institutional goals and user needs.

Overall, UdeC's findings on labeling clarity, navigation depth, and semantic fit strongly resonate with the literature. The challenges identified (from unclear labels to deep menus) are not unique; they reflect widespread IA issues in university portals and other large websites. Crucially, the UdeC study reinforces the importance of early IA evaluation (via tree testing and related methods) as a means to achieve global best practices in navigation design. By comparing these results with international studies, we see a convergent understanding that user-centered IA improvements (clear terminology, intuitive grouping, shallow hierarchies, and thorough pre-design testing) are key to creating effective and user-friendly information architectures in higher education contexts.

The study provides a detailed, multiprofile evaluation of the portal's information architecture, but several limitations should be acknowledged. The small sample sizes for groups such as parents and university officials limit the generalization of the findings. The evaluation also relied solely on textual tree testing, which does not capture visual cues, layout effects or search-based navigation. The institutional diagnostic report shows that many users rely on search to locate information, indicating that this behavior was not assessed here. These limitations do not diminish the value of the findings but highlight opportunities to strengthen future evaluations through prototype testing and real usage data.

5 Conclusions

This study presented a user-centered empirical evaluation of the University of Colima's institutional web portal design, focusing on validating its information architecture through the tree testing method. The evaluation encompassed nine user profiles representing the diversity of the university community (students, faculty, administrative staff, and external visitors) and revealed both strengths and limitations in the proposed structure.

The results demonstrated that, while the portal achieved moderate to high success rates in tasks related to academic and administrative information, significant usability challenges persisted. These challenges were primarily associated with excessive menu depth, ambiguous terminology, and a lack of alignment between institutional vocabulary and user mental models. Such issues mirror those reported in international studies of university websites, where semantic mismatches and poor information hierarchy frequently reduce navigation efficiency and user satisfaction.

The study also confirmed that usability performance varied considerably across user groups. Students and external users, who are less familiar with internal terminology, encountered greater difficulty completing tasks than faculty or administrative staff. This variability underscores the importance of designing inclusive web architectures that accommodate different levels of digital literacy and contextual knowledge. It further suggests that personalization, audience segmentation, and adaptive content presentation could significantly improve the user experience in complex institutional environments.

From a methodological perspective, the integration of findings from the ESP 2021 report [12] into the task design ensured that the evaluation was grounded in real user needs identified through large-scale institutional diagnostics. This continuity between diagnostic and validation phases represents a best practice for university portal redesign projects, aligning quantitative usability metrics with qualitative evidence about users' expectations and frustrations.

Beyond its immediate implications for UdeC, the study contributes to the broader literature on information architecture and usability in higher education by offering an evidence-based approach to validating large-scale web redesigns. The combination of tree testing, cross-profile evaluation, and qualitative interpretation proved effective for detecting structural and semantic flaws that might not be visible through traditional expert review alone. This hybrid approach can be replicated by other institutions seeking to modernize their digital ecosystems while maintaining a user-centered perspective.

In practical terms, the findings support several actionable recommendations. First, the portal's information hierarchy should be simplified, limiting navigation depth to a maximum of three levels to enhance task efficiency and reduce cognitive load. Second, key content areas such as the academic calendar, scholarship opportunities, and faculty directory should be made reachable directly from the homepage or through role-specific dashboards. Third, institutional terminology should be harmonized with users' natural language, avoiding internal jargon that obscures meaning. Finally, iterative usability testing should become a standard component of the portal's maintenance cycle, ensuring continuous alignment with evolving user expectations and international usability standards.

Looking ahead, future work to improve IA should expand the scope of evaluation by incorporating complementary techniques such as card sorting to refine information grouping. Beyond IA, the design and development of a new version of the portal also requires the conduction of accessibility audits to ensure compliance with WCAG guidelines. Lastly, conducting clickstream analytics is essential to monitor real user behavior after deployment. These extensions would provide a more holistic understanding of the portal's performance and inclusiveness.

Ultimately, the study affirms that effective university portals are not defined solely by their aesthetic appeal or technical infrastructure but by their ability to facilitate intuitive, efficient, and satisfying interactions for diverse users. By systematically validating and refining its information architecture, the University of Colima takes a significant step toward establishing a digital environment that is not only usable and inclusive but also reflective of the institution's commitment to accessibility, transparency, and service excellence in higher education.

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