EDUCACIÓN Y HUMANIDADES COMO EJES DE INVESTIGACIÓN E INNOVACIÓN

Juan Francisco Álvarez-Herrero
Jordi Antolí Marínez
Pompillo Cusano

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Meléndez Valdés, 61 - 28015 Madrid
Teléfono (+34) 915442846 - (+34) 915442869
e-mail: info@dykinson.com
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Improving usability in a federated Moodle ecosystem within a European University Alliance: the Transform4Europe case study

Federica Mancini

Riccardo Fattorini

Università degli Studi di Trieste (Italia)

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Abstract: This study evaluates the usability of the federated access procedure within the Transform4Europe (T4EU) Alliance, aiming to enhance the user experience for students accessing Moodle-based online courses across partner universities. The evaluation combined usability questionnaires, heuristic evaluations, and user testing to assess the ecosystem's overall performance. Findings highlighted a generally positive experience across institutions and identified key usability issues related to error messaging, interface informativeness, and system intuitiveness. These challenges stem from the complexities of federated access in a European university alliance, where systems must accommodate mobile and local students, provide a clear language selection feature, differentiate alliance-specific courses, and manage varied enrollment and course delivery methods. In response to these findings, usability guidelines were developed to address the specific challenges of the context. Key improvements include providing clear and meaningful error messages, simplifying terminology, clarifying the authentication process, enhancing translation support, and ensuring consistent design. These measures aim to create a smoother educational experience. Moreover, this study provides valuable insights for other European Universities seeking to develop or refine their e-learning ecosystems. Future work will expand this evaluation to include additional T4EU institutions, to refine the system further and broaden its applicability.

Keywords: European Universities Alliances, federated access, mobility programmes, moodle, usability

1. INTRODUCTION

The ongoing digital transformation of university campuses and the widespread adoption of distance learning supported by the European Universities Alliances are pivotal in advancing the overarching goals of creating a more interconnected, agile, and student-centred educational ecosystem within the future European Education Area (European Commission, 2023). Central to this transformation is the enhancement of various forms of mobility, a key objective advocated by the European Commission through the 'Erasmus+ Programme 2021-2027' and the Digital Europe Programme.

Similarly, the strategic document 'Universities without Walls: A Vision for 2030' (European University Association, 2021) underscores the importance of virtual campuses in making universities ubiquitous and fostering broader access to and participation in research and learning for all. Therefore, implementing joint digital campuses within European universities' alliances generates high expectations.

However, a few years after the launch of the first- and second-wave projects, it has become evident that European universities need help in developing joint academic and administrative activities. Additionally, difficulties persist in data-sharing policies and in taking concrete actions to ensure staff and students possess the necessary digital skills.

In this context, standardisation and interoperability are becoming increasingly crucial to promote mobility and overcome the current barriers to electronic data exchange across the systems used by various European higher education institutions (Berger et al., 2023). The development of a federated e-infrastructure has been identified as a promising solution to support accessibility, and scalability for academic services (such as online libraries, virtual learning and teaching opportunities, licenses, repositories, etc.) within a standardised trust model (Felts & Carpenter, 2023; Knoth et al., 2022).

The T4EU university alliance became part of this challenging scenario in 2021 bringing together ten European universities (Saarland University (DE), University of Alicante (ES), Estonian Academy of Arts (EE), Silesian University of Katowice (PL), University of Sofia (BG), University of Trieste (IT), Vytautas Magnus University (LT), Universidade Católica Portuguesa (PT), University of Primorska (SI) and Jean Monnet University (FR)) to train knowledge-entrepreneurs and promote mobility, interdisciplinarity and inclusion.

The primary objective of the alliance to design and implement joint mobility pathways at the bachelor, master, and doctoral levels required identifying and deploying a solution that enables seamless access to the diverse course offerings provided by partner universities. To achieve this, each university established a federated e-learning ecosystem, leveraging the Learning Management Systems (LMS) already in use. A key requisite to join the federation was the affiliation to eduGAIN as both service providers and identity providers. Federated login was then integrated within each local LMS (Moodle), allowing only T4EU students to log in using their institutional credentials and automatically enrol in project-related courses.

However, authentication through eduGAIN relies on standard protocols such as SAML 2.0 or OAuth 2.0 and requires compliance with privacy regulations. As a result, login procedures must adhere to national and European guidelines, ensuring that users are informed about the legal aspects of data processing and that their authorization is obtained for sharing personal data, significantly impacting the overall user experience. Likewise, although efforts were made to harmonize access interfaces and refine the Moodle section dedicated to T4EU courses, differences in local environments remained. These differences were also likely to affect the usability of the ecosystem. As a result, following a pilot phase involving several partner universities, student feedback was collected and carefully analyzed. This data was subsequently used to provide specific recommendations to T4EU institutions, aimed at improving the usability and effectiveness of the federated e-learning ecosystem across the alliance.

2. PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

This study investigates and evaluates students' experiences in accessing online courses offered by partner institutions within a mobility program, utilizing their institutional credentials. The primary aim is to identify key usability issues that hinder seamless access to online courses across multiple institutions and to provide actionable recommendations for improving the usability of federated Moodle learning environments.

The study specifically targets students from the University of Trieste who accessed online courses through a select group of universities within the T4EU alliance, where the federated access solution was successfully implemented and tested in the project's early phases. In subsequent phases, the usability evaluation will be expanded to include additional institutions within the alliance, providing a more comprehensive understanding of the system's usability across the entire network.

The following research questions guide this study: what are the key usability challenges associated with federated access to online courses in European university mobility programs?; how can a digital learning ecosystem be optimised within a university alliance to enhance access to distance learning for mobile students?

3. THEORETICAL FRAMEWORK

The introduction of data protection regulations, such as the GDPR, alongside strengthened security measures, has accelerated the adoption of federated single sign-on (SSO) systems. These systems aim to balance privacy concerns with the demand for secure, user-friendly access to digital services by transmitting only the minimal identity information necessary for service providers to make informed access decisions (Carretero et al., 2018). Federated SSO solutions, such as eduGAIN, play a critical role in this context (Orel & Novosel, 2023). Developed by GÉANT, eduGAIN connects identity federations across research and higher education institutions worldwide, enabling secure access to resources while ensuring user privacy.

In academic settings, federated access to LMS is especially crucial for students involved in mobility programs, as it allows seamless access to educational resources across different institutions and countries (Ebner et al., 2024). However, while federated access solutions are increasingly recognized as essential for enhancing students' access to digital learning resources and services both within and outside their home institutions, while also ensuring data security, there remains a significant gap in the scientific literature concerning their usability—particularly for learners engaged in joint programs and mobility pathways.

Usability is a critical aspect of user interface design, focusing on the effectiveness, efficiency, and satisfaction with which users interact with systems. Nielsen (2012) defines usability as a multi-dimensional concept aimed at assessing how effectively, efficiently, and satisfactorily users can accomplish their goals while interacting with a system. The ISO 9241-11 standard (2018) further refines this definition, emphasizing usability as the degree to which users can perform tasks accurately, completely, and with minimal effort, while achieving a high level of satisfaction.

Usability can be measured through a variety of methodologies, each offering unique insights into the user experience. One of the most cost-effective approaches is heuristic evaluation, in which usability experts assess a user interface based on established principles or heuristics. These usability heuristics have been widely applied to evaluate e-learning systems (Erenler, 2018) for identifying usability issues early in the design process, leading to significant improvements in overall interface design. However, incorporating user testing can offer a more detailed and comprehensive assessment of the system’s performance and user experience. Usability questionnaires, a widely used subjective method, are highly valued for their cost-effectiveness and ability to provide meaningful insights into user perceptions (Aziz et al., 2021). Selecting an appropriate usability questionnaire requires two key steps: analyzing the context of the study and the specific system being evaluated, and; reviewing the questionnaire’s content, strengths, limitations, usability dimensions, and psychometric support (Hodrien & Fernando, 2021).

On the other hand, qualitative user testing, while more resource-intensive, offers deeper insights into user behaviour, motivations, and pain points. Techniques such as the Think-aloud protocol encourage participants to articulate their thoughts during task completion, shedding light on the reasoning behind their actions (McDonald et al., 2020). Moderated usability testing in controlled environments also allows researchers to gather detailed insights into participants' responses (Molich et al., 2020), ensuring

that environmental factors do not affect the outcomes. As the sample size increases, this testing method provides valuable qualitative data that reveals emerging user trends. These insights can help guide improvements in future design iterations. Interestingly, research by the Nielsen Norman Group suggests that even testing with just five users can uncover up to 85% of usability issues, with early participants often identifying the most critical problems. This highlights the effectiveness of small-scale testing in uncovering significant usability issues early on, even before larger sample sizes are involved (Nielsen, 2000).

Overall, combining various usability evaluation methods at different stages represents the most effective strategy for comprehensive usability evaluation (Wang et al., 2019). While these methods can be applied independently, viewing them as complementary components of a unified framework provides a more robust understanding of user experience and usability challenges.

4. MATERIALS AND METHODS

4.1. Usability questionnaire

An initial usability analysis was conducted with 111 students from the University of Trieste. These participants tested the access procedure for online courses offered by three T4EU partner institutions: the University of Silesia, the University of Alicante, and Vytautas Magnus University. Following the test, students completed a usability questionnaire. The entire process, including the test and questionnaire completion, took place during an in-person class session, where students used their own devices after receiving specific instructions from a research team member.

The usability questionnaire used in this study was an adapted version of Nielsen's Usability Attributes questionnaire (Nielsen & Kaufmann, 1993), which was translated from English to Italian to align with the local context. It comprised 12 items designed to assess six key usability attributes: learning, efficiency, effectiveness, memorability, error, and satisfaction. The quantitative data from the questionnaire were analyzed using Jamovi version 2.3.28.

4.2. Heuristic analysis

Qualitative data on usability issues were gathered through a heuristic analysis conducted by two usability experts, each with significant experience in usability evaluation. In addition to the original three institutions (University of Silesia, University of Alicante, and Vytautas Magnus University), the analysis also included the University of Sofia (BG), which had since implemented the federated authentication login.

To support the assessments, experts were provided with a custom list of heuristics, along with practical examples for reference. Unlike Nielsen's (1994) well-known heuristics, this study developed a set of heuristics specifically designed to address the unique requirements and challenges of the federated access system. This approach ensured that the experts had consistent guidelines, allowing them to efficiently identify key usability problems throughout the evaluation process.

4.3. Laboratory usability testing

A total of twenty laboratory usability tests were conducted with ten students from the University of Trieste who had participated in a mobility program within the T4EU project. Each student tested two procedures for accessing an online course hosted on a partner university's Moodle platform via federated authentication. As in the heuristic analysis, tests were carried out on the systems of the University of Silesia, the University of Alicante, Vytautas Magnus University, and the University of Sofia.

Tests were conducted with five participants per procedure, following Nielsen's (2000) guidelines, which suggest this sample size is sufficient to identify about 85% of critical issues while avoiding redundancy. The tests were conducted in person using the think-aloud method, with a moderator guiding participants throughout the process, and all sessions were recorded for subsequent analysis. This approach enabled cross-validation of the findings from the heuristic evaluation while also gathering additional qualitative insights, which further enhanced the understanding of user interactions and usability challenges.

The research team analyzed the recordings using qualitative coding techniques. To ensure inter-rater reliability, two researchers independently coded all observations from each session using Atlas.ti. Inter-rater consistency was calculated using the formula from Miles and Huberman (1994), where reliability is the ratio of agreed-upon codes to total codes within each student's input. The categorical coding scheme was developed a posteriori, with keywords derived from the data (Creswell, 2013). Coders reviewed the results iteratively until an inter-rater reliability of 80% was achieved.

5. RESULTS

5.1. Phase 1: questionnaires

The students completed the usability questionnaire after testing the access procedures for their assigned institutions. A total of 116 tests were conducted; however, five outliers were identified and excluded from the analysis due to their mean scores significantly deviating from the typical range, either falling below 1 or above 3.90 (specifically 0.00, 0.75, 0.75, 0.92, and 4.00). As a result, the final number of tests per institution was as follows: a) University of Alicante: 36 tests; b) University of Silesia: 40 tests; c) Vytautas Magnus University: 35 tests.

An ANOVA was conducted to assess whether significant differences existed in the dependent variable and to identify the factors influencing these differences. The analysis focused on three primary factors: universities, items, and the interaction between universities and items. The results, which include F-values (measuring effect size), degrees of freedom (df, indicating the precision of the F-value), and p-values (indicating statistical significance) for each factor, are summarized as follows: a) Universities: The F-value is 2.19, with 2 degrees of freedom and a p-value of 0.116. This indicates no significant differences between the universities in terms of user experience, as the p-value exceeds the conventional threshold of 0.05. Consequently, environmental factors related to the universities appear to have little impact on the user experience; b) Items: The F-value is 2.93, with 11 degrees of freedom and a p-value less than 0.001, suggesting significant differences between the items. This result indicates that different items exert varying effects on the dependent variable, emphasizing their distinct impact on the user experience; c) Interaction between universities and items: The F-value for this interaction is 1.06, with 22 degrees of freedom and a p-value of 0.389, which is not statistically significant. This suggests that the influence of the items does not vary across universities, and the interaction between these factors does not significantly affect the user experience.

In conclusion, the findings reveal no significant differences between universities, indicating a consistent user experience across institutions. However, notable differences were observed among the items, suggesting that their effects on the user experience vary. The analysis also showed that the interaction between universities and items does not significantly influence the results. Therefore, while the items differ from one another, the universities do not significantly impact these differences, nor is there a meaningful interaction between the two factors.

Additionally, the chi-square analysis assesses which scores exceed the average by examining the results for each item. The findings indicate that all items, except for items 9 and 10, have significant scores ($p < .001$), with responses predominantly concentrated at point three on a five-point Likert scale ranging from zero (minimum) to four (maximum). In contrast, items 9 and 10 show significant values associated with response 2 on the scale (Table 1). This suggests that the overall user experience, as reported by the 111 participants in the questionnaire, is generally above the average score of 2.5.

Table 1. CHI-Square, graph for 111 subjects.

	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6	
Resp 3	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Observed	49	44	59	53	49	44	48	43	56	50	57	51
Expected	*22.2*	*20*	*22*	*20*	*22.2*	*20*	*22.2*	*20*	*22.2*	*20*	*22.2*	*20*
	Item 7		Item 8		Item 9 *Resp2		IItem 10 *Resp2		Item 11		Item 12	
Resp 3	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Observed	57	51	58	52	39	35	33	29	51	6	62	56
Expected	*27.8*	*25*	*22.2*	*20*	*18.5*	*16.7*	*18.5*	*16.7*	*22.2*	*20*	*27.8*	*25*

The results, broken down by item, highlight some critical issues (Table 2). Specifically, item 9 ("The error messages presented during navigation tell me how to solve the problems") received significantly lower scores compared to the other items ($t(1181df) = -4.535$; $p < .001$). This suggests that the error messages during navigation fail to provide clear guidance on resolving the issues encountered. Similarly, item 3 ("I easily found the information I was looking for") scored lower than the other items, although the difference was not statistically significant. This suggests that users often face difficulty in finding the information they are seeking.

Table 2. Means, standard error for individual items with respective confidence intervals (CI).

			95% CI					95% CI	
Item	Mean	Standard error	Lower	Upper	Item	Mean	Standard error	Lower	Upper
1	2.64	0.0872	2.47	2.81	7	2.60	0.0872	2.43	2.77
2	2.64	0.0872	2.47	2.81	8	2.69	0.0872	2.52	2.87
3	2.44	0.0872	2.27	2.61	9	2.23	0.0927	2.05	2.41
4	2.60	0.0872	2.43	2.77	10	2.53	0.0911	2.35	2.71
5	2.62	0.0872	2.45	2.79	11	2.50	0.0872	2.32	2.67
6	2.56	0.0872	2.39	2.73	12	2.54	0.0872	2.37	2.71

This preliminary macro-level analysis offers valuable insights into the usability of federated access to courses within the ecosystem, highlighting its strengths and improvement areas. While the overall Moodle ecosystem proves to be usable for the majority of users, two critical aspects emerge that require attention: error management and, to a lesser extent, the challenge of locating desired information. Specifically, the

error messages displayed during navigation fail to provide clear, actionable guidance, leaving users struggling to resolve the issues. This lack of effective error communication can hinder the overall user experience, leaving users frustrated and confused when faced with problems they cannot resolve quickly.

5.2 Phase 2: heuristics

The heuristic evaluations conducted across four universities identified a range of problems impacting one or more institutions, which can be traced back to the usability attributes outlined in the questionnaire (Table 3).

Tabla 3. Identified issues from the heuristic evaluation.

Heuristic	Related attributes and items	Affected institutions
Match between the system and the real world: identifying the login page for T4EU federated students is challenging due to the use of unfamiliar terms and concepts, such as EduGain, Shibboleth, and federated IDs, combined with a confusing layout design.	*Learning:* "This system is simple to use" *Memorability:* "The system is easy to remember" The difficulty in identifying the login page indicates that the system is neither simple to use nor easy to remember, affecting both learning and memorability.	1
Federated authentication procedure: the federated authentication process, along with the required steps, is not intuitive, causing users to become easily confused or lost along the way.	*Efficiency:* "I was able to quickly complete my task with this system" *Effectiveness:* "The information provided during navigation allowed me to access the course" *Error:* "When I made a mistake using this system, it was easy and quick to correct it" A complex authentication process reduces efficiency and effectiveness and increases the likelihood of errors.	2
Translation: some elements and content are not properly translated, making it difficult for non-native speakers to navigate the system efficiently.	*Satisfaction:* "This access procedure has all the functions and potential to match my expectations" *Efficiency:* "I easily found the information I was looking for" The lack of adequate translations compromises user satisfaction and their efficiency in completing tasks.	1
Course location: finding T4EU courses within Moodle after authentication is not an intuitive process.	*Efficiency:* "I easily found the information I was looking for" *Satisfaction:* "This access procedure has all the functions and potential to match my expectations" The difficulty in finding courses affects both efficiency and satisfaction, potentially leading to user frustration.	3

Consistent design: the design deviates from the T4EU Alliance branding guidelines, with inconsistencies in colour schemes and logo usage, undermining user trust and familiarity.	*Satisfaction:* "The interface of this system is nice" *Memorability:* "The system is easy to remember" Inconsistent design undermines satisfaction and the ability to remember the system, making it feel less familiar and trustworthy.	2
Logout: the logout function does not redirect users to the login page as expected.	*Effectiveness:* "The information provided during navigation allowed me to access the course" The lack of redirection after logout affects the system's effectiveness, confusing users.	2

5.3 Phase 3: tests

The analysis of the video recordings from the tests led to a more thorough and refined identification of critical issues. Researchers independently reviewed the data, coding both the screen recordings and participants' verbal feedback. Each issue was assigned a descriptive code, starting with those identified in the heuristic evaluation and progressively uncovering additional areas of concern.

As shown in Table 4, the test results highlight significant issues with the informativeness of the interfaces and error management, confirming the findings from the questionnaire. Errors during the access process were frequent, prompting students to seek assistance from the moderator as they were unable to resolve the difficulties on their own. Therefore, the absence or inadequacy of a clear informational architecture hindered error prevention, while the lack of effective error resolution mechanisms left users struggling to recover from issues. These factors led to frustration and decreased task efficiency.

Tabla 4. Test results overview.

Category	Emerged from	Type of issues	Frequency	Affected institutions
Error messages	Test analysis	The student finds the error messages unhelpful in guiding them toward a solution or effectively resolving the issues they encounter.	10	4
Information supporting the experience	Test analysis	The information available during navigation is either absent or insufficiently informative, lacking the necessary detail to enhance comprehension and prevent errors.	10	4
Logout	Heuristic analysis	The student is unsure whether they have successfully logged out, as they are not redirected to the login page.	7	4

Course Location	Heuristic analysis	After logging into the local Moodle, students are directed to a calendar view, where they struggle to locate their courses, as they are not displayed there.	6	2
Match between the system and the real world	Heuristic analysis	The student cannot correctly identify the federated login, as it is indicated by the EduGAIN logo, which is unknown to users.	5	1
Translation	Heuristic analysis	The student experiences dissonance due to untranslated elements in the local Moodle after login.	4	3
Consistent design	Heuristic analysis	The student does not recognize which courses are offered under T4EU, as there is no distinction through colour coding or the use of the logo.	4	2
Federated authentication procedure	Heuristic analysis	The student is unaware that they are on the institution's local Moodle platform and must click on the institution's logo to open the login window and access it with their institutional credentials. Additionally, the authorization windows that appear for the identity provider to release information confuse users and hinder quick access to the course.	4	2
Key features visibility	Test analysis	The student translates content from the local language to English using browser extensions instead of utilizing Moodle's built-in language selection feature.	3	1
Visual affordance	Test analysis	The student believes the logo is not clickable.	1	1

The importance of clear information and meaningful error messages lies in the fact that the federated access procedure in the context of a European university is unfamiliar to many students. Indeed, while some students have used federated access to online libraries or other academic services within their institution, the european alliance scenario introduces additional complexities, including: diverse authentication processes: authentication methods must accommodate both mobile and local students, leading to variations in login procedures; language selection requirement: a dedicated language selection feature is crucial for accurately interpreting page content; alliance-specific educational offerings: within a european alliance, distinct educational offerings must be differentiated from other courses to prevent confusion; varied enrollment and course delivery: enrollment and course delivery methods vary depending on decisions made by individual universities or faculties, resulting in a heterogeneous landscape. This

combination of factors makes the access process less intuitive and increases the likelihood of errors, despite overall item scores being above average.

5.4. Usability guidelines for federated e-learning ecosystems in european universities alliances

Improving the access procedure and providing clear, detailed information can significantly enhance the student experience, making their academic journey within the T4EU alliance more seamless. Based on the findings from usability tests, a set of guidelines has been developed to address the identified issues in the federated access procedure and the complexities introduced by the new scenario.

The priority is to ensure the use of support resources, such as FAQs or video tutorials, to assist users and prevent errors. Step-by-step guidance should be provided for tasks like course enrollment or withdrawal, helping users navigate these processes with ease. To prevent common errors, proactive suggestions and automatic feedback should be implemented. For example, reminders for incomplete logouts or prompts for incorrect credentials can help users avoid frustrating mistakes. Error messages must also be clear, and actionable, and provide users with specific solutions. Links to the relevant steps should be included, making it easier for users to resolve issues quickly.

Additionally, the system needs to use clear and familiar terminology, aligning with user expectations and real-world experiences. Technical terms such as eduGAIN, Shibboleth, or federated authentication should be avoided, and the language should be simplified to be easily understandable by all users. This alignment between the system's language and the real world is critical for improving accessibility and usability.

The federated authentication procedure should adopt an intuitive design. The login process for local and mobile students should be visually differentiated, with a simple, linear interface that clearly distinguishes the two options. The placement of university logos for federated access authorization should be carefully considered, as positioning them on the left side of Moodle may confuse users into thinking they are links to local courses. Additionally, while the authorization procedures may remain complex, they should be accompanied by concise, user-friendly explanations. These explanations should clarify why certain permissions are required to release attributes and guide users through the process, helping them understand and complete it more easily.

Translation management should focus on ensuring comprehensive language support across all pages. All pre-login and post-login pages should be translated at least into English, simplifying the experience for users from different linguistic backgrounds. The visibility of language selection features in Moodle should also be enhanced. Using clear icons or pop-up alerts will guide users to the built-in language options, removing the need for browser extensions and improving the overall user experience.

For course access, the system should avoid redirecting students to the calendar page upon login. Instead, users should be directed straight to the course page, where clear filters can help distinguish active, upcoming T4EU-specific courses. Simplifying navigation through distinct menus, breadcrumbs, or tabs will further improve the accessibility of courses. Consistency in design is crucial for a smooth user experience. A colour-coding system, combined with the consistent application of the T4EU logo, will help differentiate T4EU alliance courses from other local courses. The overall layout of local Moodle environments should maintain a standardized structure across all stages of navigation and enrollment, ensuring that users can easily identify T4EU-related elements.

The logout process should also be streamlined. After logging out, users should always be redirected to the login page, accompanied by a visible confirmation message such as "Logout successful. You can log in again here." This provides clarity and reassurance.
Finally, visual affordance should be enhanced. It is crucial to ensure that clickable buttons and logos are easily identifiable, signalling interactivity. This can be achieved through cursor changes, tooltips, and visually intuitive designs, which will help users navigate the system more effectively.
By following these guidelines, the system will become more user-friendly and cohesive, allowing all users to navigate and interact with the platform with ease and confidence.

6. CONCLUSIONS

The usability evaluation across multiple phases of testing provides valuable insights into the federated access process within the T4EU alliance. While the overall experience for students was generally positive, several critical areas for improvement were identified.
The analysis of the questionnaires revealed that the user experience did not vary significantly between the universities involved, suggesting that environmental factors related to individual institutions have a minimal impact on perceived usability. However, notable differences were found in specific items, particularly those related to error messages and information retrieval, indicating that these aspects of the access process influence the user experience more than others.
The findings from the heuristic evaluations and tests offered a more detailed understanding of the usability of the federated Moodle ecosystem, helping to pinpoint specific areas in need of improvement. Notably, they emphasize the critical need for clear error messages and sufficient support information throughout navigation, reinforcing the results from the questionnaires. These challenges underscore the necessity for a more intuitive system, one that is easily navigable by all students, regardless of their familiarity with federated authentication.
Based on these findings, a set of usability guidelines has been developed, offering actionable recommendations to enhance the federated access experience. These guidelines emphasize the importance of clear terminology, intuitive authentication processes, comprehensive language support, and consistent design to reduce confusion and improve user satisfaction. Implementing these changes will not only enhance the system's accessibility for students but also support the broader goals of the T4EU alliance in creating a cohesive and efficient digital campus experience across institutions. Future studies will expand the usability assessment to include students from additional alliance institutions that have successfully implemented the eduGain federation in the interim.

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