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Research Article

MERAKI: An Online Collaborative Learning Platform Developed Using the UWE Methodology

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Abstract: In the digital era, education has evolved with the integration of technologies that optimize the teaching-learning process. This article presents the need for more efficient online collaborative environments that overcome the limitations of traditional platforms, fostering meaningful interaction between students and teachers. To address this need, the collaborative platform “MERAKI” was developed using the UML-Based Web Engineering (UWE) methodology. This structured methodology, based on UML diagrams and an iterative and incremental approach, facilitated the development of a flexible and adaptable system. The platform integrates technologies such as HTML, CSS, JavaScript, Python, Flask, and PostgreSQL, providing a robust environment with tools for thematic forums, resource sharing, and personalized academic tracking. In contrast to commonly used platforms, which often present challenges such as unintuitive interfaces, limited learning analytics, high costs, or a lack of educational focus, MERAKI addresses these gaps through improved usability, targeted tools for academic interaction, and a user-centered design. User testing revealed high levels of satisfaction, with an average rating of 4.26 out of 5 across aspects like communication, collaboration, and academic organization. These results highlight MERAKI’s effectiveness in enhancing engagement and managing educational activities in virtual environments. The key findings of the model indicate that MERAKI not only offers a comprehensive and personalized solution for collaborative learning but also presents high scalability and adaptability potential for future innovations in digital education, including its application in contexts such as technical education and corporate training.

Keywords: Interaction, Uml-Based Web Engineering, Educational Environment, Communities of Practice and Motivation to Learn

Introduction

Education in the digital age has transformed teaching and learning by integrating technologies that enhance accessibility and efficiency. However, many educational platforms still face significant limitations in fostering collaboration between students and teachers. According to UNESCO (2020), more than 70% of educational platforms worldwide lack robust tools for collaborative interaction, negatively impacting student engagement and participation. This absence of effective interaction mechanisms contributes to academic isolation, which correlates with higher dropout rates in distance education programs (Means *et al.*, 2021).

Collaborative learning methodologies based on ICT promote knowledge construction through dialogue, negotiation, and joint reflection (Corporan *et al.*, 2019). However, current platforms often prioritize content delivery over meaningful interaction (OECD, 2021), overlooking an essential aspect of learning: Teamwork.

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Group activities not only foster cooperation but also strengthen critical thinking and problem-solving skills (De Prada *et al*., 2022). Despite these benefits, studies reveal that 65% of students in online courses feel they lack sufficient interaction with their peers, which affects information retention and motivation (Vithana *et al*., 2023).

In this context, there is a need for a platform that not only facilitates access to educational content but also fosters continuous collaboration within an academic community. MERAKI addresses this issue by providing an interactive digital environment where students can learn from each other, improve their communication skills, and engage in shared discussions. Additionally, it incorporates tools to track individual participation, enabling educators to monitor engagement levels and promote an equitable learning environment.

The objective of this study is to develop a digital space that enhances student collaboration, motivation, and study habits. Through MERAKI, the aim is to foster continuous learning, explore new knowledge areas, and create a more dynamic and engaged academic community.

Background

In the past, the implementation of web technologies in teaching and learning processes was uncommon, as their development was primarily focused on industrial and commercial sectors. However, over time, the growth of these technologies led to their adoption in education, enabling a more efficient and accessible learning process.

The COVID-19 pandemic further highlighted the need for digital tools to ensure the continuity of education while maintaining health and safety measures. As a result, many institutions adopted web-based platforms that facilitated interaction between teachers and students, access to study materials, and learning in virtual or hybrid environments.

Even though the World Health Organization (WHO) has declared the end of the global health emergency, digital education remains relevant, strengthening its role as a key complement to improving educational quality and accessibility.

Several studies indicate that research on collaborative learning and virtual platforms focuses on knowledge construction, social interaction, and the development of critical thinking skills (Tomalá De la Cruz *et al*., 2020). Collaborative learning allows students to share valuable information and develop essential social, cognitive, and emotional skills.

However, as noted by Tomalá De la Cruz *et al.* (2020), mere interaction among students is not enough; structured strategies are needed to facilitate effective knowledge exchange and construction processes.

Similarly, Malpartida Gutiérrez *et al.* (2021) state that virtual collaborative learning environments enable participants to enrich their knowledge through peer contributions. This approach fosters critical, innovative, and creative thinking while enhancing students' ability to synthesize information. Kerimbayev *et al.* (2020) highlight that interactive communication in digital platforms not only improves learning but also promotes a culture of virtual collaboration, making educational content more accessible and engaging.

Among the most widely used educational platforms is Moodle, a learning management system that allows educators and students to organize courses in a secure and customizable environment. Its accessibility and ease of use have contributed to its widespread adoption, reducing technological and economic barriers. Google Classroom has also gained popularity by facilitating class management and communication between students and teachers (Gómez, 2020). Likewise, Microsoft Teams integrates chat, video conferencing, and file storage, providing a collaborative workspace for remote education. Blackboard, on the other hand, combines in-person and online learning, offering educational management tools that optimize both the learning experience and institutional administration.

The most important factor for successful analysis and interpretation of information is the optimal organization of data, which is why significant time must be invested in properly planning the organizational infrastructure and data storage and retrieval processes so that they can be accessed easily, efficiently and effectively (Chumbimuni De la Cruz *et al*., 2024; Vega-Huerta *et al*., 2024; Moquillaza-Henríquez *et al*., 2025).

To better understand the impact of MERAKI in the educational environment, it is essential to analyze how it compares to other platforms. Below, in Table 1, is a comparative evaluation that considers key aspects such as usability and learning outcomes. Additionally, it specifies the limitations of each platform and how the proposed solution aims to address these challenges.

Virtual Learning Communities

Virtual learning communities bring together individuals with a common interest to exchange knowledge, share information, and enhance their education through digital collaboration. Their purpose is to foster a participatory environment where each member can freely express themselves and contribute to collective learning. Unlike traditional educational models, these spaces dissolve the hierarchy between expert and learner, encouraging a dynamic in which all participants take an active role in exploring and constructing knowledge (Morales, 2019).

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Table1: Comparison of MERAKI improvements with other learning platforms

Platform	Learning Outcomes	Limitations	MERAKI Improvements
Moodle	Varies depending on implementation	Unintuitive interface for new users, steep learning curve	More user-friendly and intuitive interface, easier customization
Google Classroom	Depends on teacher-student interaction	Limited assessment and tracking tools	More advanced learning analytics and increased dynamic interaction
Microsoft Teams	Good	Not specifically designed for education, more business-oriented, may be complex for some users	Education-focused experience with specific tools for interactive learning
Blackboard	Good	High cost and requires training	Greater accessibility and cost reduction for educational institutions

In addition to providing access to diverse information and experiences, these communities promote the development of key skills such as teamwork, critical thinking, and autonomous learning (Dzib Moo and Laury, 2020). By allowing each participant to progress at their own pace and according to their needs, they enable a more flexible and inclusive educational approach. In this sense, virtual learning communities not only strengthen individual and collective knowledge but also foster a sense of belonging and commitment among their members essential aspects in an increasingly interconnected world.

Educational Technologies

Various studies have highlighted that the integration of technology in education contributes to the development of essential skills and competencies for students' future careers. However, as Castañeda *et al.* (2020) warn, its adoption should not be seen as an end in itself but rather as a means to enhance teaching and learning processes.

According to Bryant *et al*. (2020), the effectiveness of educational technologies largely depends on the experience and maturity of both students and the educational systems that implement them. In this regard, their adoption requires not only an adaptation process for students but also solid educational structures to maximize their impact. Likewise, Bryant *et al.* (2020) emphasize that the success of educational technology relies on an approach in which both teachers and students actively participate. When teachers lead its implementation and tailor it to the needs of the educational environment, its impact is significantly greater. This reinforces the idea that technology should not replace the role of the teacher but rather complement it. To achieve effective integration, it is crucial not only to have the right devices but also to implement pedagogical strategies that ensure its use with a clear and meaningful purpose.

Social Presence

Social presence refers to students' ability to express themselves socially and emotionally in an online environment, playing a key role in educational platforms. Its absence can lead to feelings of isolation and negatively impact the learning experience (Aldosari *et al*., 2022).

One of the biggest challenges of distance learning is the limited interaction between students, which makes it difficult to build a sense of community and can affect academic outcomes. To address this, it is essential to implement strategies that promote collaboration and active participation, ensuring a continuous social presence that strengthens the sense of belonging within the group.

In this regard, Fiock (2020) highlights the importance of designing instructional strategies that enhance social presence in virtual environments. Integrating collaborative group dynamics, using technological tools that facilitate communication, and implementing interactive activities are some of the recommended measures to improve student engagement and foster a more enriching learning experience.

UWE Methodology (UML - Based Web Engineering)

UWE is a software engineering approach for the web domain that aims to cover the entire life cycle of web application development. The key aspect that distinguishes UWE is the reliance on standards. This methodology is a model-based engineering approach that focuses on assisting the web engineer in the different phases of the development lifecycle (Molina-Ríos & Pedreira-Souto, 2020).

In this methodology, use cases, scenarios and extended glossaries are used to specify the requirements of the Web application, which provides greater accessibility and management of the system requirements. In addition, UWE has a special focus on customized or adaptive applications. UWE consists of 3 dimensions:

- Structural Dimension: Focuses on the layout and organization of the web application. It determines how the system components are distributed and how they interrelate, facilitating the understanding of the architectural design. It is expressed through the content diagram, which focuses on the modeling of classes and their interconnections

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- Navigational Dimension: This dimension is dedicated to examining how users inter- act with the application. Navigation within the application is designed to show how users move between its various sections. This is essential to ensure agile and accessible user experience, considering elements such as tab design and content organization
- Presentation Dimension: Deals with the visual representation of the web application. It establishes how data should be displayed and the design of the user interface, considering both aesthetics and functionality. Paying attention to this dimension ensures that the application not only fulfills its functional purpose but is also attractive and easy to use for end users
- The characteristics of UWE allow covering the entire software life cycle of web applications, maintaining a focus on the user. Its structure is an iterative and incremental model, which facilitates the control of constant changes during the execution of the project (Molina-Ríos & Pedreira-Souto, 2019)

Related Works

Various studies have explored the use of web technologies in education. For example, a study analyzed digital tools such as Zoom, Google Docs, Padlet and Canvas within teacher training processes, highlighting their effectiveness in promoting virtual collaboration and reducing educational isolation. However, they also pointed out difficulties in maintaining interaction over time and in adequately managing content, which shows the need for more structured environments that guarantee the continuity of the learning process (Weaver *et al*., 2021). MERAKI aims to address these limitations by providing a platform that facilitates collaboration and content sharing among users, allowing for a more structured integration of educational resources and enhancing the experience in virtual environments.

On the other hand, a study explored online collaborative learning compared to face-to-face and individual modalities, using platforms such as Zoom and Desmos in an educational context in the Philippines. Their results showed improved academic performance in virtual group activities; however, only 12 of the 20 participating students passed the final assessment, suggesting that collaborative interaction, while beneficial, does not always translate into effective knowledge retention. In addition, the study identified unstable connectivity and low participation by some students as significant barriers, factors that may limit the success of online collaboration (Mapile and Lapinid, 2023). The proposed platform seeks to address these challenges by offering an optimized infrastructure and strategies that promote equitable user participation, ensuring that collaboration in virtual environments not only enhances interaction but also strengthens autonomous and meaningful learning.

Finally, another study analyzed the impact of ubiquitous collaborative learning, a model that combines constant access to digital resources with real-time collaboration among students of different nationalities. Although an improvement in academic performance associated with the course structure and collaborative dynamics was observed, no statistically significant relationship was found between student motivation and academic achievement (Daungcharone *et al*., 2024).

Furthermore, the lack of a statistically significant relationship between motivation and academic achievement suggests that the mere availability of tools does not guarantee effective learning. In this regard, MERAKI seeks to overcome these limitations by providing a structured environment that facilitates interaction and guides the learning process, promoting equitable participation and the development of critical skills in digital environments.

Methods

The UWE methodology will be used, as previously explained, this methodology consists of 3 main dimensions that allow us to generate several UML diagrams to have a clear vision of the web platform under development and to be able to code it correctly from the needs of the system and the users. In addition, this methodology meets the transactional requirements, which are found internally in the system needs.

For coding, a combination of robust and versatile technologies was chosen to ensure the creation of an interactive and collaborative environment. The implementation was carried out using markup languages such as HTML for the structure, CSS for the design and JavaScript for the front-end interactivity. For the back-end development, Python was selected as the main language, taking advantage of the Flask framework for the creation of routes and the efficient management of client requests. Flask is a microframework used for web application development in Python.

As mentioned by Flaviu (2021), Flask has three main dependencies: the Werkzeug WSGI (Web Server Gateway Interface) toolkit, the Jinja2 template and the Click command line interface. This powerful framework offers native support for user authentication, database access and web form validation, among other functions, which are provided through extensions that integrate with the core packages. In addition, it is highly flexible, allowing you to decide how to structure and organize the application, adapting to the specific needs of the project without imposing a fixed structure.

The choice of PostgreSQL as the database management system was essential to ensure efficient and reliable storage of user-generated information.

PostgreSQL, as an open-source relational database, offers robust architecture that prioritizes data integrity, extensibility, and compliance with SQL standards. Its ability to handle large transaction volumes with high performance, along with support for advanced operations such as optimistic concurrency and efficient indexing, significantly enhances system efficiency. The integration with the data flow was carried out seamlessly, ensuring fast and secure access to stored information. Additionally, its compatibility with multiple programming languages and support for JSON, stored procedures, and advanced queries facilitate interoperability, allowing different system modules to communicate effectively.

The coding process was carried out following agile development practices, allowing the system to adapt to continuous changes and improvements. A modular code design was implemented to ensure long-term maintainability, facilitating future updates and system expansions, and promoting the reuse of existing components. This coding phase was crucial for transforming the system's conceptualization into a fully functional and scalable web application, ready for deployment and evaluation in a real environment. Additionally, continuous testing was conducted during this stage to ensure software quality.

Figure 1 presents a summary of the methodology detailed in this section.

Results

This section details the results after the implementation of the web page using the selected methodology, as well as a discussion of the results obtained.

Implementation

Initially, it was essential to define and understand both functional and non-functional requirements, ensuring that the system would meet end-user expectations and be able to deliver a complete experience. Table 2 presents the main requirements that guided the development of the system.

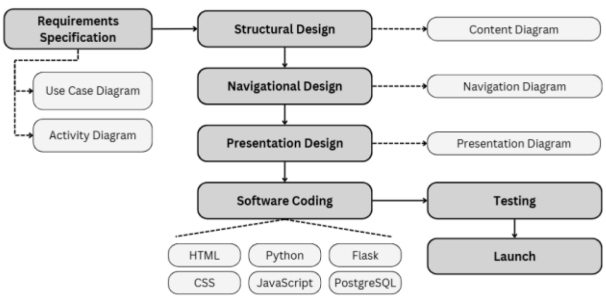

Fig. 1: Summary of the methodology

Table 2: Specification of requirements

Require-ment	Type	Description	Justification
RF01	Functional	Create, join, and explore communities.	Encourages collaboration and knowledge sharing.
RF02	Functional	Interact in thematic forums.	Facilitates collaborative learning.
RF03	Functional	Share and rate study resources.	Provides access to high-quality educational content.
RF04	Functional	Integrate study tools.	Enhances the learning experience.
RF05	Functional	Verify interaction and collaboration.	Evaluates participation and system effectiveness.
RNF01	Non-Functional	Create customizable communities.	Provides a more engaging experience.
RNF02	Non-Functional	Implement secure authentication and encryption.	Protects user data and access.
RNF03	Non-Functional	Design an intuitive and accessible interface.	Facilitates navigation and use across devices.
RNF04	Non-Functional	Ensure optimal response times.	Guarantees smooth and scalable operation.

During the requirements specification phase, the use cases were defined and represented in Figure 2, which organizes the system's main functions into five key sections.

The first section, "Home Page" (RF01), covers the creation and exploration of communities. Here, users can register, log in, join or create communities, manage tasks, and view announcements. "Forum" (RF02) enables participation in thematic discussions, allowing users to create and comment on topics, as well as view a ranking based on engagement.

In "Sharing" (RF03), users can publish, rate, and access study resources, with a ranking system that highlights the most valued contributions. The "Discover" (RF04) section facilitates access to study tools, enabling users to explore and add new resources as needed.

Finally, "Progress" (RF05) provides an overview of activity and collaboration within the community, displaying both group and individual progress.

These sections define the platform's core functionalities, enhancing the collaborative learning experience for students and educators.

In terms of security, a secure authentication mechanism was implemented using a Python-based

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encryption method for password protection, ensuring the security of user credentials. Furthermore, encryption protocols were applied to data transmission, reinforcing the integrity and confidentiality of the information stored in the PostgreSQL database.

The system was deployed in the cloud via Heroku, allowing access from any device with an internet connection without requiring local installation. This cloud-based infrastructure facilitates the scalability and maintenance of the platform, ensuring both optimal performance and continuous availability.

Regarding hardware and software requirements, accessing the platform only requires an updated web browser and a stable internet connection. On the server side, Heroku provides the necessary computational resources, optimizing memory usage and processing power. The PostgreSQL database is also hosted in the cloud, allowing for efficient and secure access to information.

The system design, based on the UWE methodology, clearly established the relationships between users, their actions, and the various components of the platform. Students and teachers interact with the system through specific modules, where they can access, manage, and share information according to their roles. This structure facilitated the software implementation and validation, ensuring optimal functionality before its launch. The following section details each phase of the applied methodological process.

Structural Dimension

First, the design of the database structure that will manage all the information in the system was carried out. As illustrated in Figure 3(a), the database is composed of several interrelated tables, which ensures data integrity and consistency, and optimizes performance in queries and operations

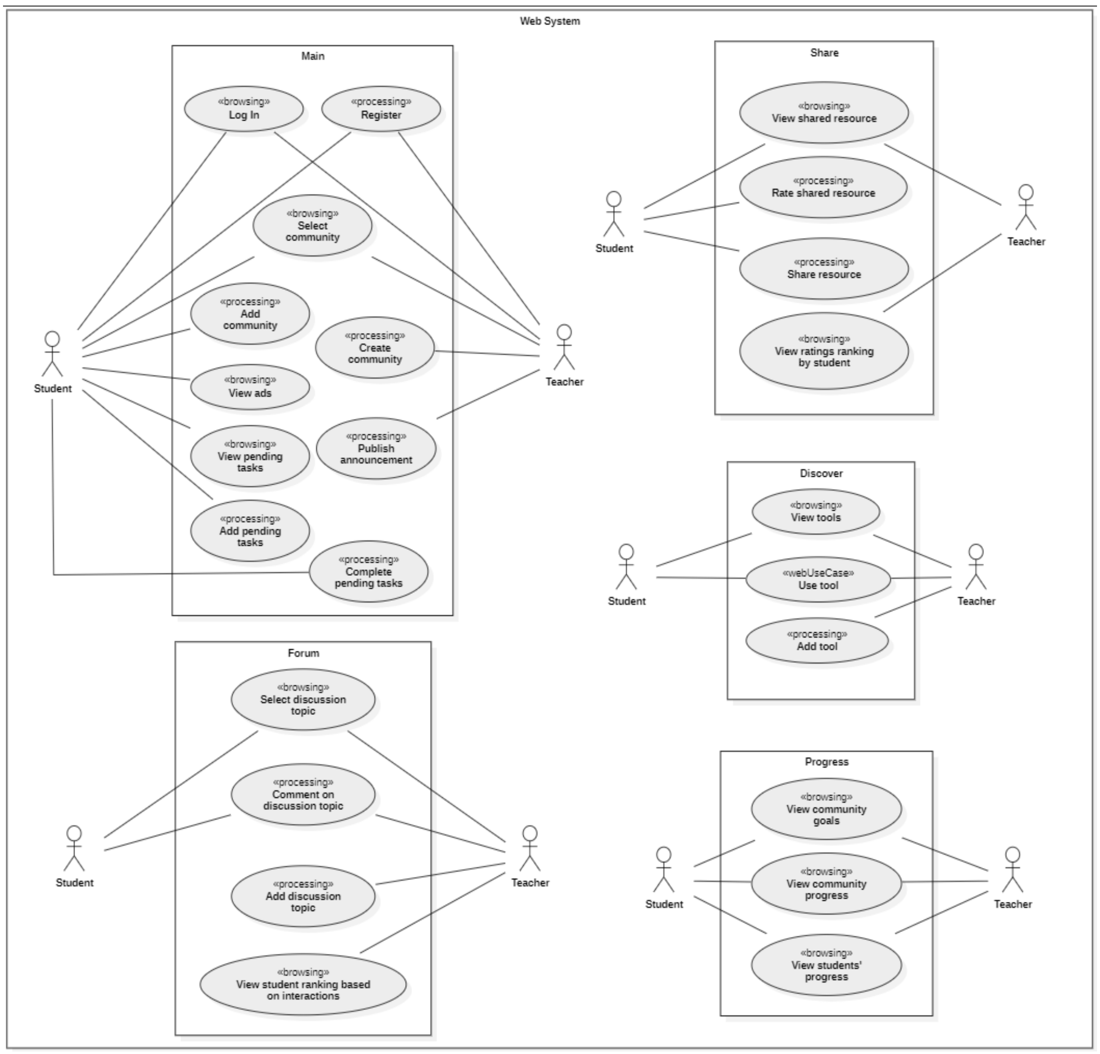

Fig. 2: Use Case Diagram

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In addition, the organization of the tables is designed to reflect the logical relationships between the different types of data, ensuring that the structure is scalable and adaptable to future expansions of the system.

Navigational Dimension

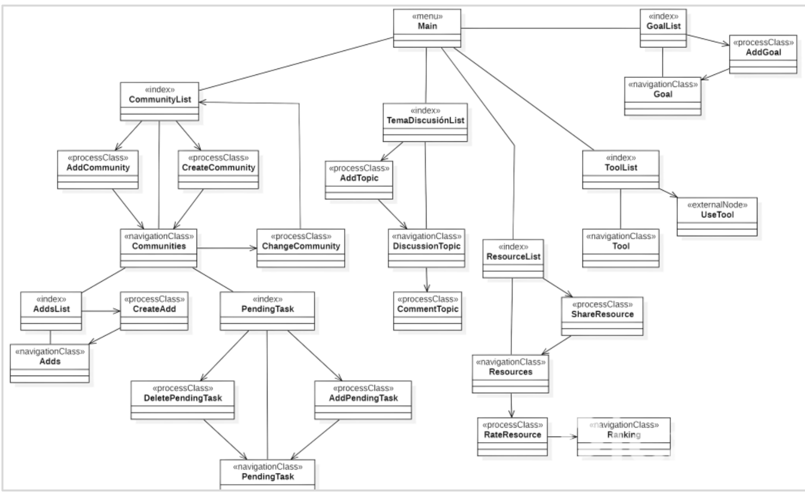
On the other hand, Figure 3(b) presents a diagram that specifies the navigation flow within the system, allowing us to identify how users interact with the page and what elements are necessary for its proper functioning. This diagram is key to understanding the user experience, as it illustrates the system's entry and exit points, as well as the available actions at each stage, facilitating the detection of bottlenecks and areas where interface usability could be improved.

To verify the usability of the navigation, exhaustive tests were conducted during development, focusing on the layout, content distribution, and overall system functionality. These tests allowed us to introduce significant changes, such as menu reorganization and adjustments to the information layout, aiming to optimize the user experience.

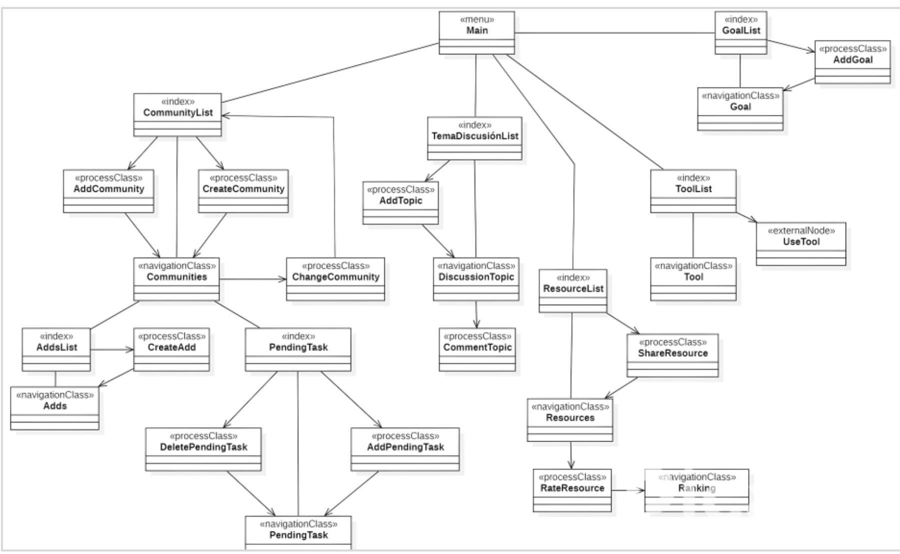
Presentation Dimension

In this phase, multiple diagrams were developed to preview the user interface and how the content will be distributed throughout the web page. As an example, Figure 3(c) shows a prototype of what would be the main page when logging into the system. As can be seen, the content of the tab is specified, as well as the elements that could be observed by each type of user according to the role with which he/she has registered.

Once the three dimensions were completed, the web page was coded based on the defined structures and the respective tests were carried out to verify its correct functioning.



(a)



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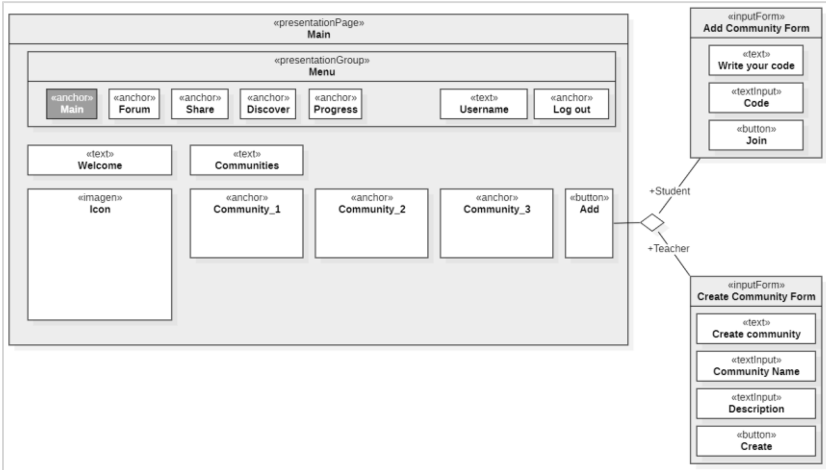


(c)

Fig 3: Content (a), Navigational (b) and Presentation (c) Diagrams

Once the 3 dimensions were completed, the web page was coded based on the defined structures and the respective tests were carried out to verify its correct functioning.

Solution Description

The platform features an initial space designed for hosts or instructors, where they can share important announcements and view a summary of social presence in collaborative and interactive activities (Figure 4a). This indicator helps identify the most active members within the community.

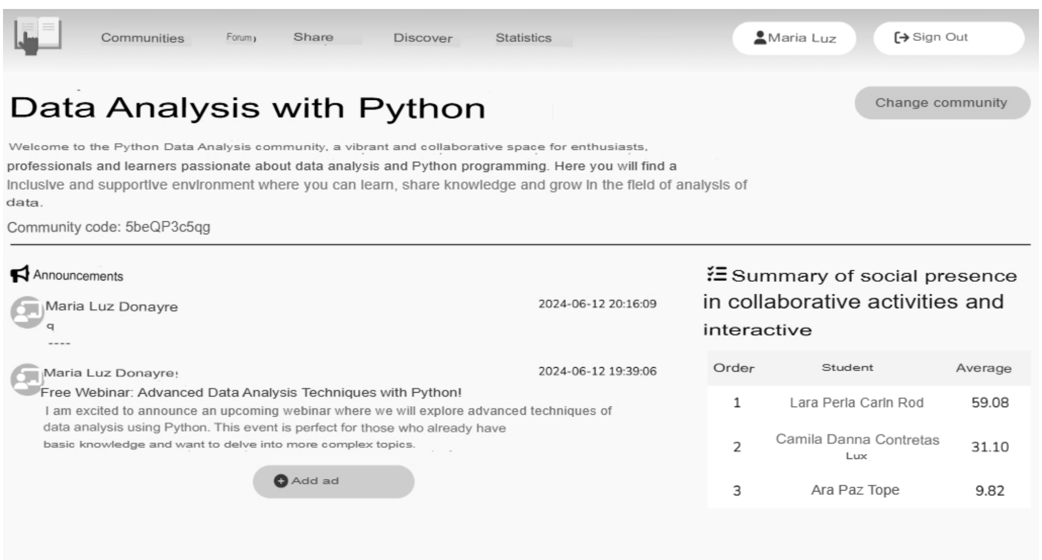
For a more detailed analysis, a dedicated tab displays the level of interaction and collaboration of each use (Figure 4b), allowing instructors to monitor each participant's activity.

Among the main features, the forum provides a space where students can discuss topics defined by the instructor (Figure 4c). Each interaction whether a comment, reply, or reaction contributes to the calculation of the social presence indicator in interactive activities.

Additionally, a section has been integrated for sharing relevant resources, where collaborators can rate their usefulness (Figure 4d). Both the number of shared resources and the ratings received influence the calculation of the social presence indicator in collaborative activities.

Additionally, hosts have an exclusive space to provide essential learning tools (Figure 4e). The platform

includes four default resources and tracks the frequency of access to them, allowing for an evaluation of their usage and the participants' level of interest.



(a)

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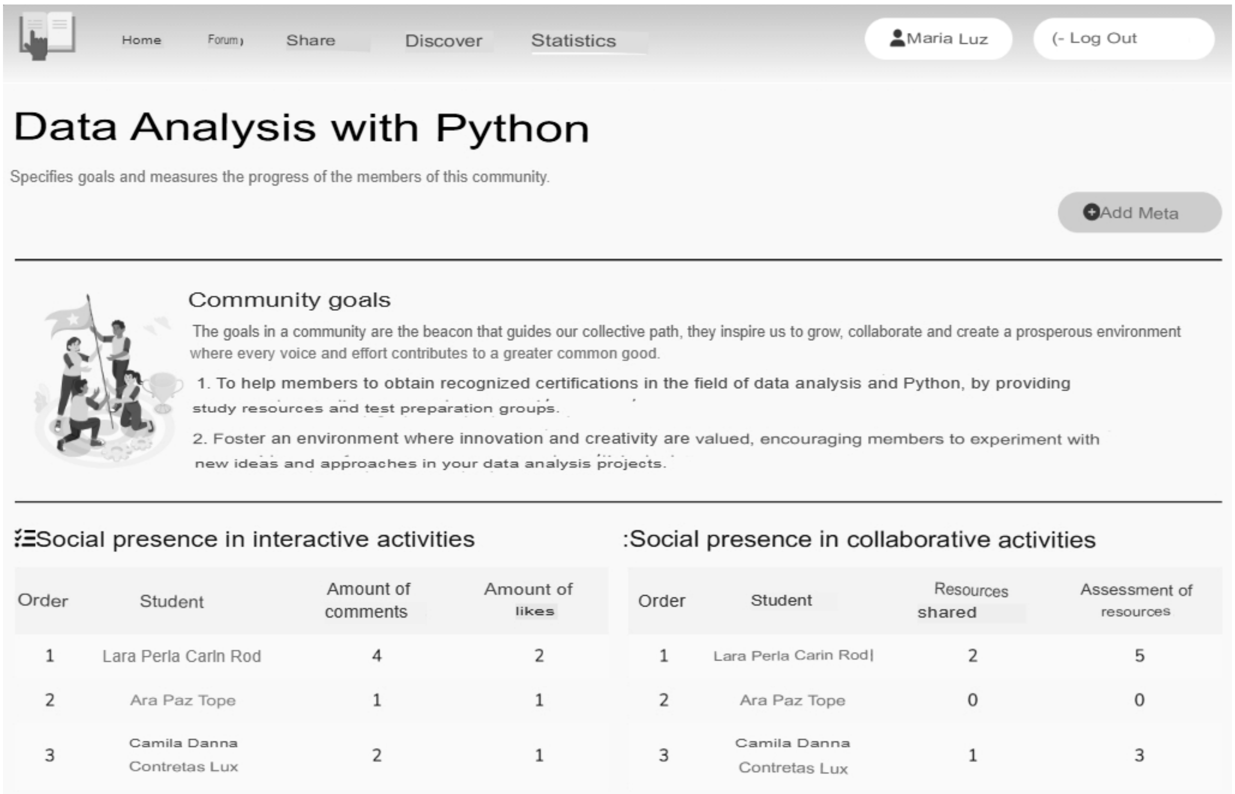

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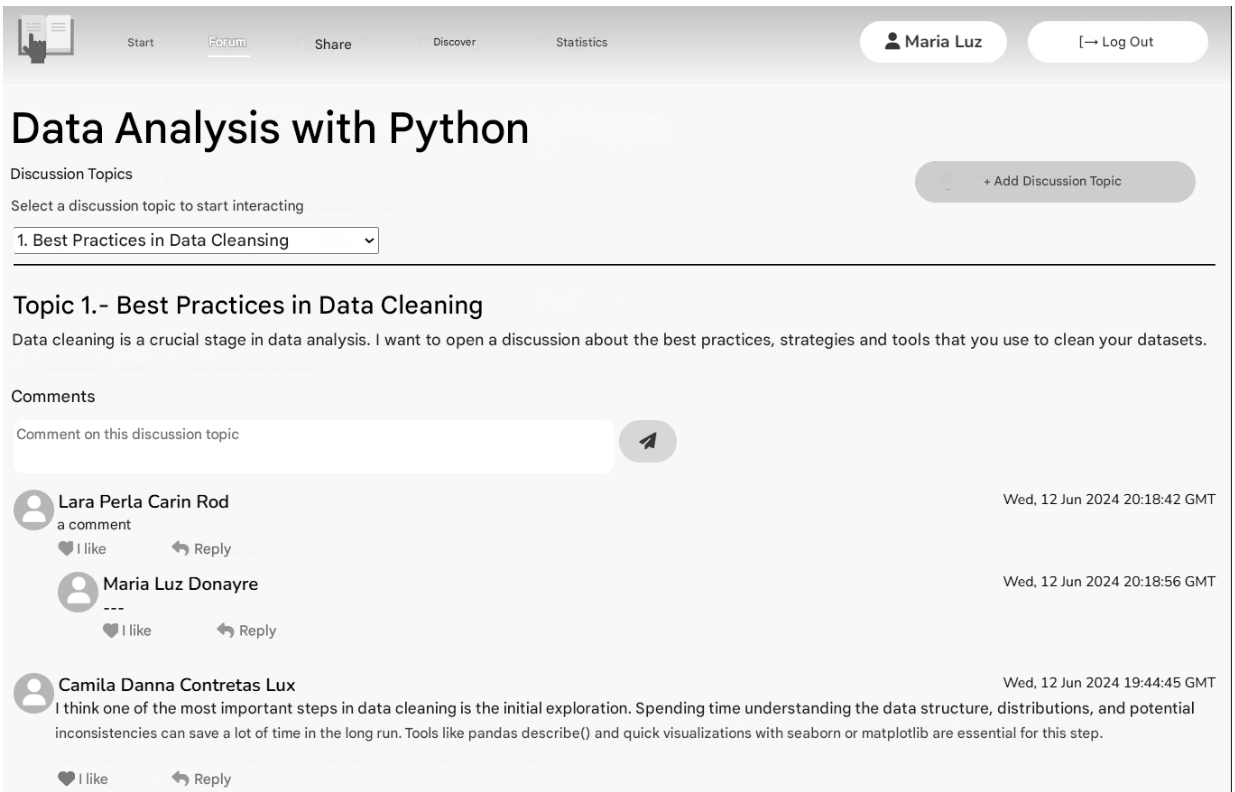

(c)

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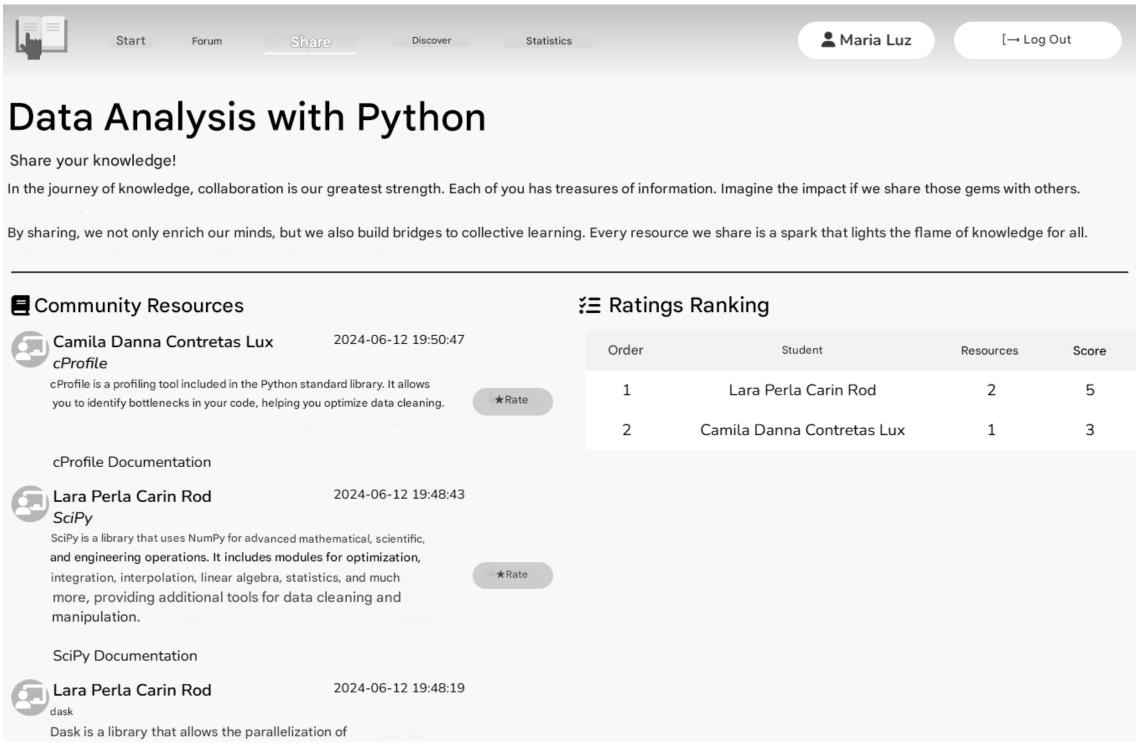
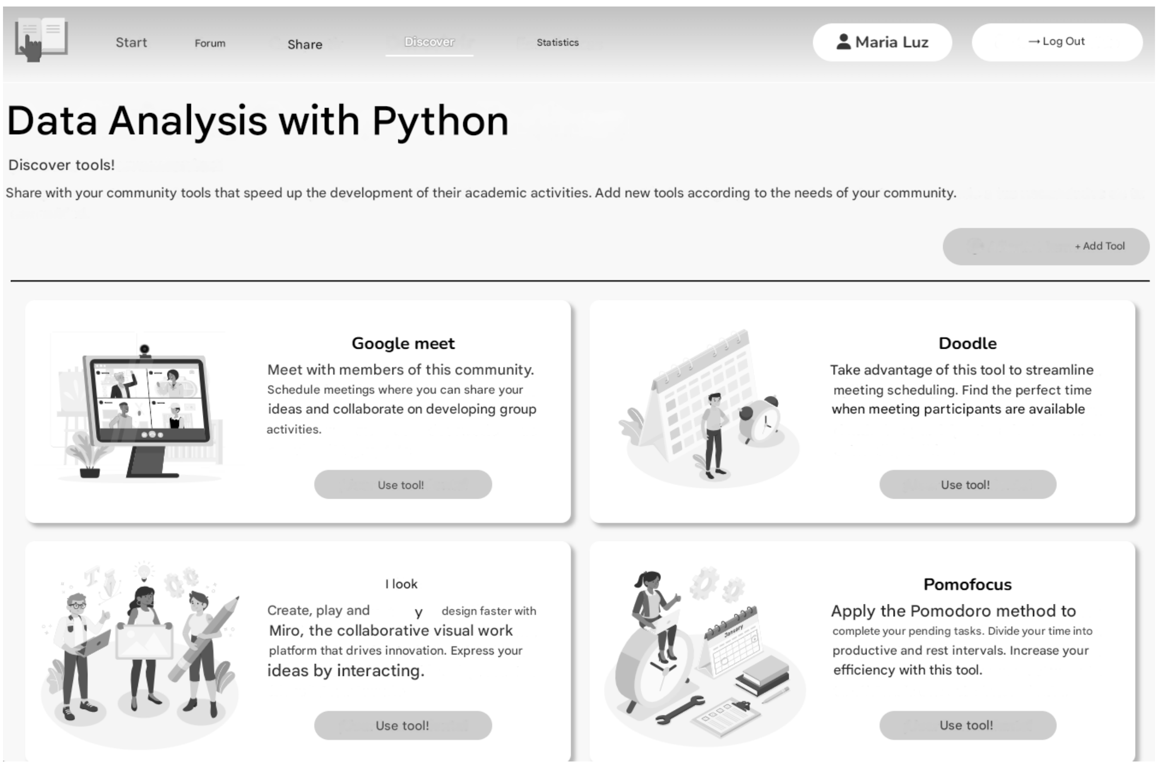


(d)



(e)

Fig. 4: Web Page Tabs

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Table 3: User Perception of MERAKI's Communication and Learning Features

Question	Average Response
Does the MERAKI platform facilitate communication among members of your class, group, or academic community?	4.22
Does the MERAKI platform promote communication and interaction among collaborators?	4.11
Does the MERAKI platform facilitate the use of different tools among its collaborators?	4.22
Does the MERAKI platform allow you to expand your knowledge on topics related to your class, group, or community?	4.11
Does the MERAKI platform help reinforce topics related to your class, group, or community?	4.44
Does the MERAKI platform allow you and your peers to share study materials?	4
Does the MERAKI platform help you organize your academic activities related to the class, group, or community you belong to?	4.56
Does the MERAKI platform motivate members to learn about topics related to the class, group, or community they belong to?	4.44
Average	4.26

Testing

The application of the UWE methodology allowed MERAKI to be implemented in a structured and efficient manner, ensuring an interactive environment for teachers and students. To evaluate its functionality, the platform was tested with nine students from an educational institution in Lima, Peru, who, under the guidance of a teacher in the tutoring course, used it for two weeks.

During this period, participants explored various collaboration tools, engaging in thematic forums, sharing resources, and accessing features designed for group learning. The intuitive interface facilitated adoption, aligning with studies such as that of Faudzi *et al*. (2024), which highlight the positive impact of user-centered design on motivation and participation.

Additionally, the platform enabled the collection of data on interaction and collaboration levels, providing key insights to assess student engagement and the effectiveness of the implemented tools.

To assess users' perception of the platform's usefulness and ease of use, a survey was conducted at the end of the trial period, as shown in Table 3. The questions focused on evaluating communication and interaction among participants, the organization of academic activities, and access to study materials. The survey used a Likert scale from 1 to 5, where 1 represented the lowest rating and 5 the highest satisfaction.

Discussion

The results obtained from the implementation of MERAKI using the UWE methodology support the effectiveness of collaborative virtual environments in education. Structuring the development through UML diagrams facilitated an organized implementation, ensuring the integration of key tools for interaction and collaborative learning.

To evaluate users' perception of the platform, a pilot. test was conducted with nine students from an educational institution in Lima, Peru. They used MERAKI for two weeks in a tutoring course under the guidance of a teacher.

The survey applied at the end of the trial period showed high ratings in key aspects such as communication (4.22/5), academic activity organization (4.56/5), and motivation for learning (4.44/5). These results indicate that the platform successfully fostered interaction and better structured collaborative learning, aligning with previous studies that highlight the positive impact of educational platforms on student engagement (Faudzi *et al*., 2024).

Although the survey reflected a positive perception of MERAKI's usefulness, it is still necessary to measure its impact on learning through concrete indicators, such as improvements in academic performance. To achieve this, it is recommended to conduct longitudinal studies that compare students' performance before and after using the platform.

The comparison with platforms such as Moodle, Google Classroom, and Microsoft Teams shows that MERAKI stands out for its focus on personalization and the integration of collaborative tools without the need for external add-ons. Additionally, being hosted in the cloud through services provided by Heroku, it is possible to manage high user loads and adjust the system according to user requirements, thus ensuring the platform's optimal performance.

Conclusion

The implementation of the collaborative system "MERAKI" using the UWE methodology proved to be an effective strategy for developing learning platforms in virtual environments. The use of UML within this methodology enabled structured planning and efficient coding, ensuring that system requirements and user needs were addressed clearly and precisely.

MERAKI has a database composed of 14 interrelated tables that ensure information integrity, along with interfaces designed to foster interaction including thematic forums, shared study tools, and participation monitoring facilitating a user-centered learning experience. Compared to other educational platforms, MERAKI stands out for its focus on personalized learning, detailed tracking of individual performance, and integration of collaborative tools without external add-ons.

The platform was validated with a group of nine students over a two-week period, during which it demonstrated remarkable performance in both functionality and usability. It achieved an average satisfaction rating of 4.26 out of 5, with particularly high scores in academic organization (4.56), learning motivation (4.44), and communication among users (4.22), reinforcing MERAKI's effectiveness in educational environments.

It is recommended to continue exploring emerging technologies to further enhance the platform's capabilities. Integrating artificial intelligence could enable more advanced personalization through automated recommendations based on user performance, while longitudinal studies would help assess its actual impact on academic outcomes. Additionally, expanding its application to other educational contexts, such as technical training or corporate learning, would help validate its versatility and strengthen its position as an innovative tool for collaborative learning.

MERAKI is a robust, flexible educational solution aligned with the challenges of contemporary digital education, reinforcing the value of structured methodologies like UWE in designing web platforms for the educational field.

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Author's Contributions

Yesenia Torres-Donayre: Conceptualization, Formal Analysis, Software, Resources, and Writing Original Draft.

Percy De-la-Cruz-VdV: Conceptualization, Formal Analysis, Software, Resources, and Writing Original Draft.

Hugo Vega-Huerta: Methodology, Project Administration, Visualization, and Writing Review & Editing.

Gisella Luisa Elena Maquen-Niño: Methodology, Project Administration, Visualization, and Writing Review & Editing.

Javier Cabrera-Díaz: Investigation, Software, Methodology, and Writing / Review & Editing.

Santiago Moquillaza-Henríquez: Investigation, Software, Methodology, and Writing / Review & Editing.

Luis Guerra-Grados: Data Curation, Validation, Supervision, and Writing / Review & Editing.

Ethics

This manuscript adheres to all the ethical standards outlined in the publication policies of the journal. All participants were informed about the purpose of the study and provided their informed consent before participating.

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