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"Ecosystem for European Education Mobility as a Service: Model with Portal Demo (eMEDIATOR)"

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INTERNAL REPORT 5:
Technological component of the portal

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Abbreviations and Acronyms:

Content

1. A2.5. Design of formal and informal education services (UL)

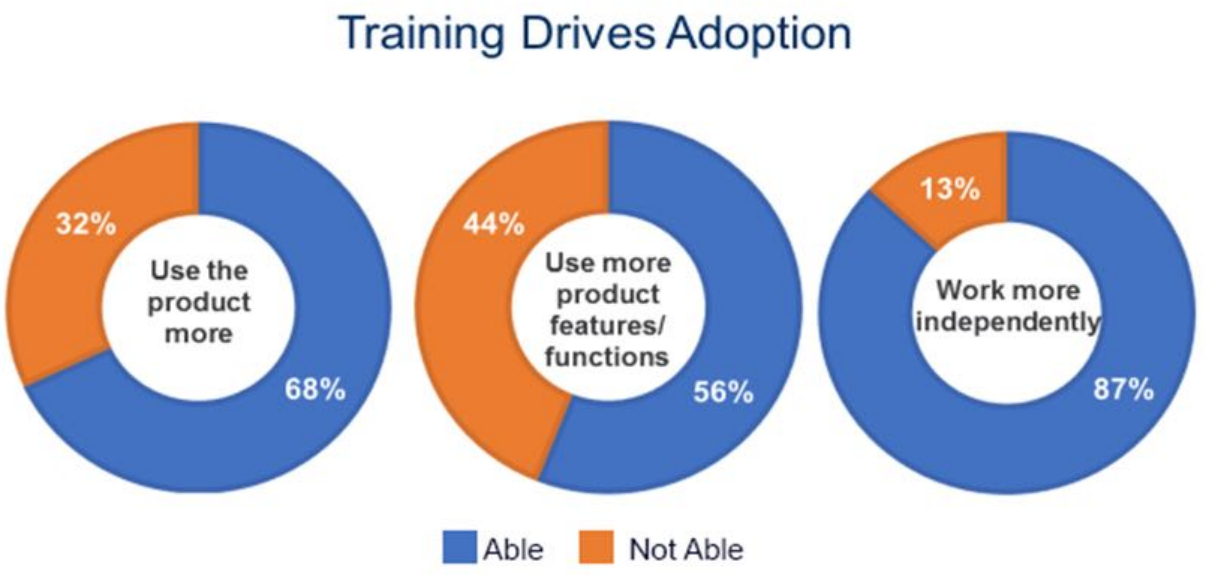
1.1 Modern approach to formal and informal education service

Education services is a function that utilizes customer training and learning opportunities to drive product usage and engagement, leading to increased customer adoption of a product or service.

The educational services consist of:

- the creation, evaluation and improvement of educational programs,
- improving teaching process and faculty members' skills,
- transforming the learning experience into one as significant for users/learners,
- transformation of educational process into one as cost-effective and efficient as possible,
- promoting continuous education,
- orientation towards the creation and promotion of innovation in all activities and educational processes.

Currently, and especially in the (near) future, all these processes and activities can be supported by artificial intelligence.



Source: https://www.tsia.com

SurveyTitle	QuestionTitle	OptionTitle	OCI Stat
ES Benchmark	6A. Using the definition of "free" provided in Q6, what percentage of ES offers are free vs. fee-based?	Fee-based	76.2%
		Free	23.8%

Source: https://www.tsia.com

The following graph shows the percentage response for each of the three statements in the above list. Using the product more, using more product features and functions, and working more independently are all measures of product quality. Therefore, if we want to measure the quality of services of the eMediator platform, it could do it partly automatically, through:

1. measuring the number of page visits (determining trends, increase or decrease)

2. measuring the number of new features and functionalities of the platform

3. the scope of users' freedom, consisting in the technical possibility of introducing or developing new solutions, threads and topics.

Moreover, users should be able to rate the platform anonymously, but their ratings are not public, but only for the administrator's attention.

1.2 The design of formal and informal education services from the perspective of organization, competence, pedagogy, and technology

In the eMediator project we create a special ecosystem that allows education and professional development for all, without boundaries, anytime, anywhere. Digitalization, accessibility, also safety (no exposure to e.g. biological threats while traveling), equal chances in education and professional development are key advantages that build the rationale for the mobility platform development. One of the tasks is to provide a design of formal and informal education services. For the eMediator project the design of formal and informal education services should fit the four interconnected components: organization, competencies, pedagogy, and technology (Gawlik-Kobylińska et al., 2023). Regarding organization, the design of the formal and informal education services it is important to think of the process in an organizational manner. Therefore, strategic, tactical, and operational levels were distinguished. Strategic level includes objectives of regional systems as well as professional and personal goals and needs (treated separately). This corresponds to the questions: why educational mobility efforts are taken? What are their goals and motivations? The second level, tactical, includes ways of formal education, non-formal learning and informal learning. Although there is a generic division into formal and informal education services, it is vital to stress that in some resources it is possible to distinguish non-formal

and informal learning. Non-formal learning is normally structured learning (e.g. in-company training) and informal learning happens naturally as part of diverse activities (e.g. digital skills developed through leisure activities) (Europass European Union, n.d.). The question that will correspond to this level is: what kind of educational effort can be taken? How can the goals and motivations be realized? The third level is operational, and it includes participants of educational process (teachers and learners), and main factors that influence educational process (such as teaching materials, methods, didactic tools which are developed and realized by teachers, and personality, preferences and learning styles, competencies that are connected with a learner. On the operational level technology and administration play a vital role. Technology creates boundaries for didactic forms and methods and administration facilitates the whole educational process. It is vital to stress that ethical behaviors should govern all organization of the educational process. Ethics has an impact on decisions on what is morally correct or incorrect and can impose a specific system of values to be obeyed. Education services can be connected with value co-creation which is related to transparency between design parties of a service enables an internally strong network, trust between parties is based on rich co-operation, shared expertise increases motivation for common value co-creation (Haukkamaa et al., 2012). In this way formal and informal educational services are realized in a friendly and safe environment. Figure 1 presents the design of formal and informal education services in the eMediator ecosystem from the perspective of organization. It is vital for the perspective of "Mobile Education as a Service" stakeholders and customers.

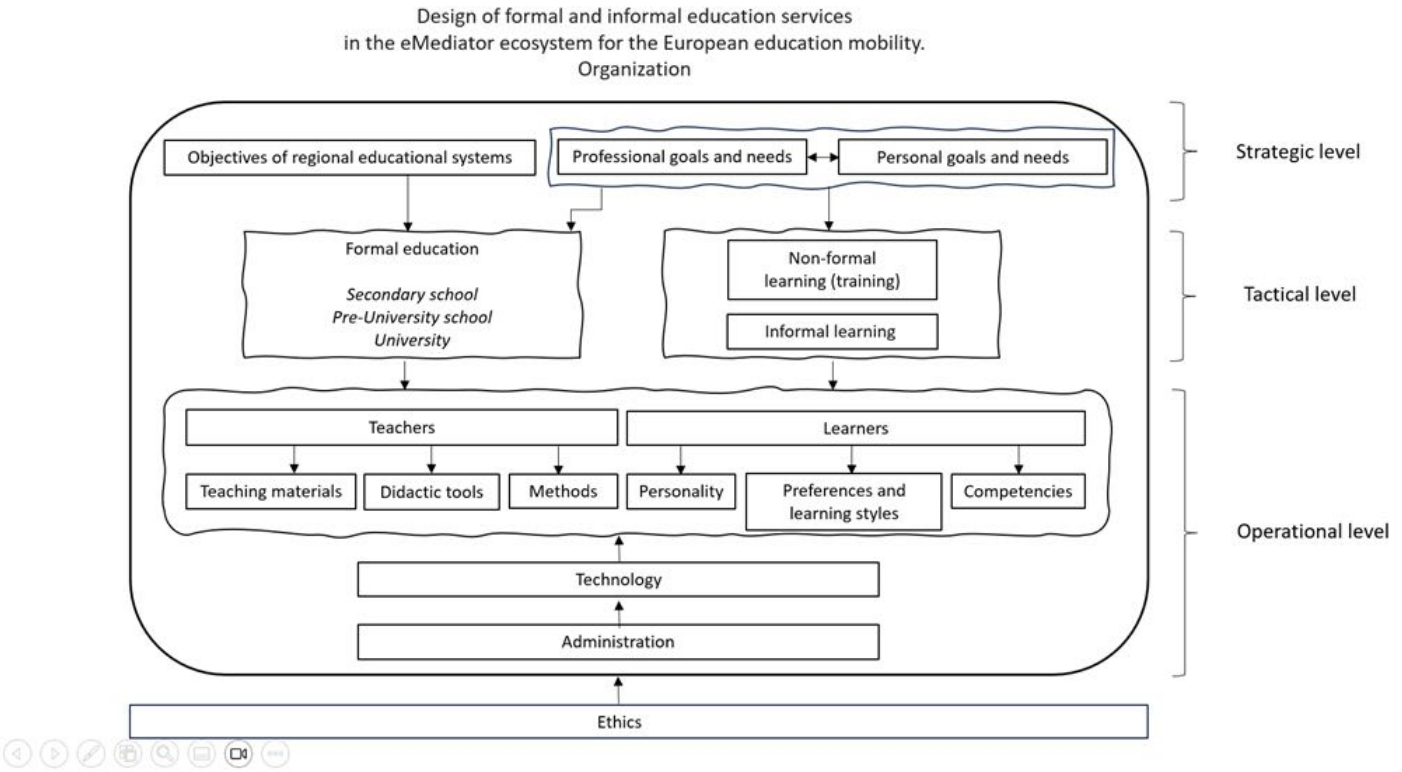


Figure 1. Formal and informal education services from the perspective of organization

Organization category fits in principles formulated in the project assumptions, specifically in the principle of service-oriented education, and principle of academia-business partnerships. Competence category is related to the principle of competency-based learning. Pedagogy category – the principle of student-centered education, while technology – to the principle of open resources (Misnevs & Kabashkin, 2023).

From the perspective of competencies, both formal and informal learning apply to the main components of competencies: knowledge, skills, and attitudes (Fig. 2). Among many approaches concerning competencies, for instance, competence as ability/capability, as a disposition, a process, a relation, quality or state of being, integration and combination of resources (Schneider, 2019), we concentrated on the definition that it is an integrated set of capabilities that arises from clusters of knowledge, skills and attitudes (Mulder, 2011) as it reveals a broader approach towards different ways of learning.

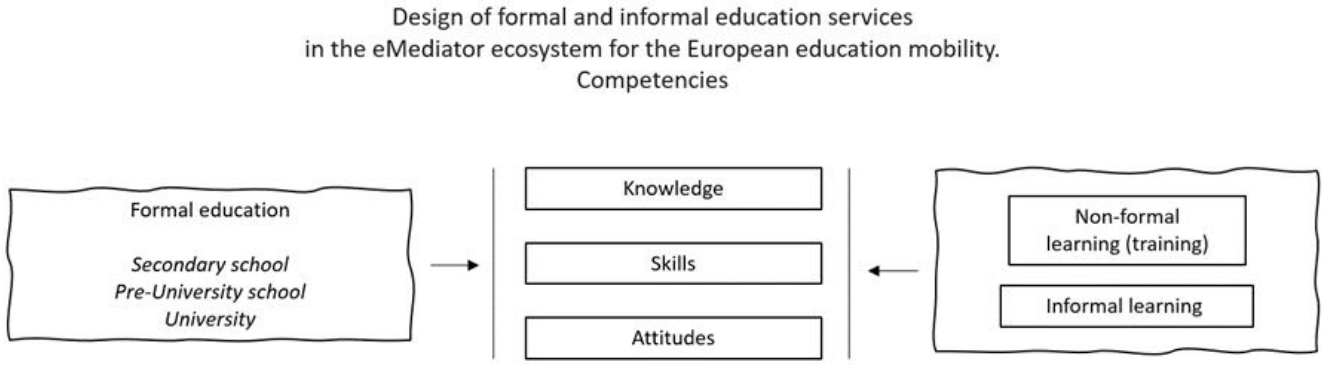


Figure 2. Formal and informal education services from the perspective of competencies

Mobility for education and professional development in two will also apply a pedagogical component, in which the education services will focus on four dimensions of learning: cognitive, psychomotor, social, and psychomotor (Gawlik-Kobylińska, 2018). It also covers experiential learning which can be realized through game-based activities (Saleem et al., 2022), storytelling (Kukul, 2023), focus on personalization thanks to AI (Li & Wong, 2023) (Fig. 3).

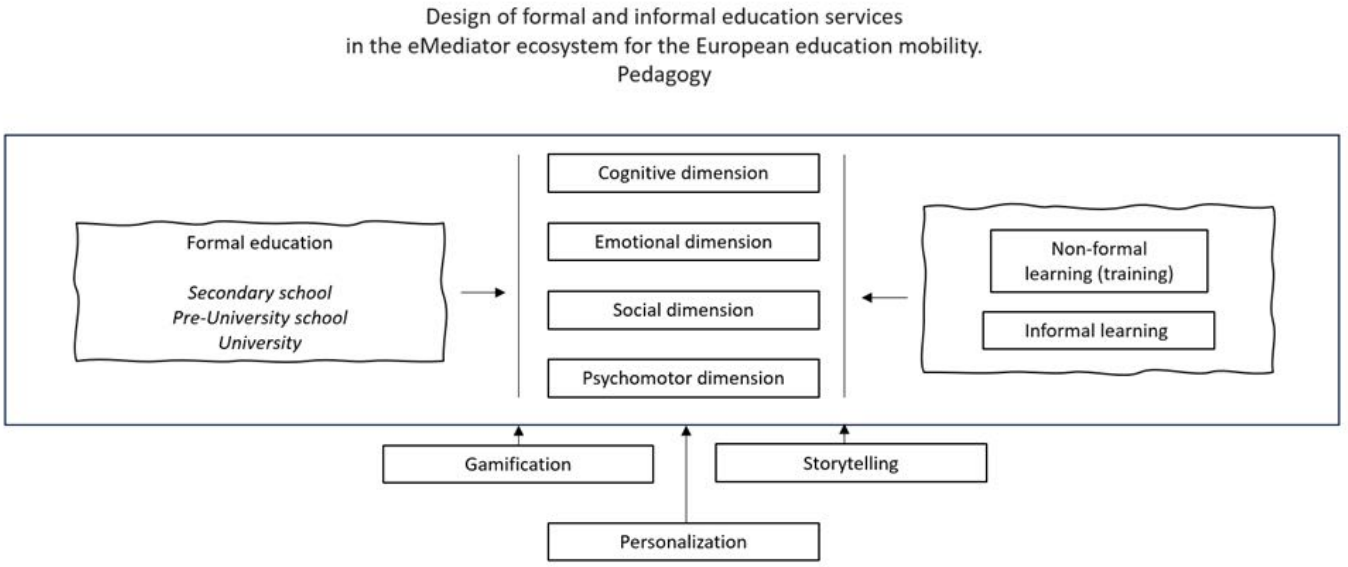


Figure 3. Formal and informal education services from the perspective of pedagogy

Regarding a technological component, the main assumptions are that the educational mobility services should be service-oriented and competence-based (with a list of required competences). They rely on user (external functionality) requirements and software (digital platform) requirements. The system will rely on cloud service, and it will be in the form of a digital platform based on existing cutting-edge technologies (machine learning algorithms for big data analytics) (Fig. 4). Its architecture is constructed considering further model's extension, enhancement, and User Experience recommendations of education management systems.

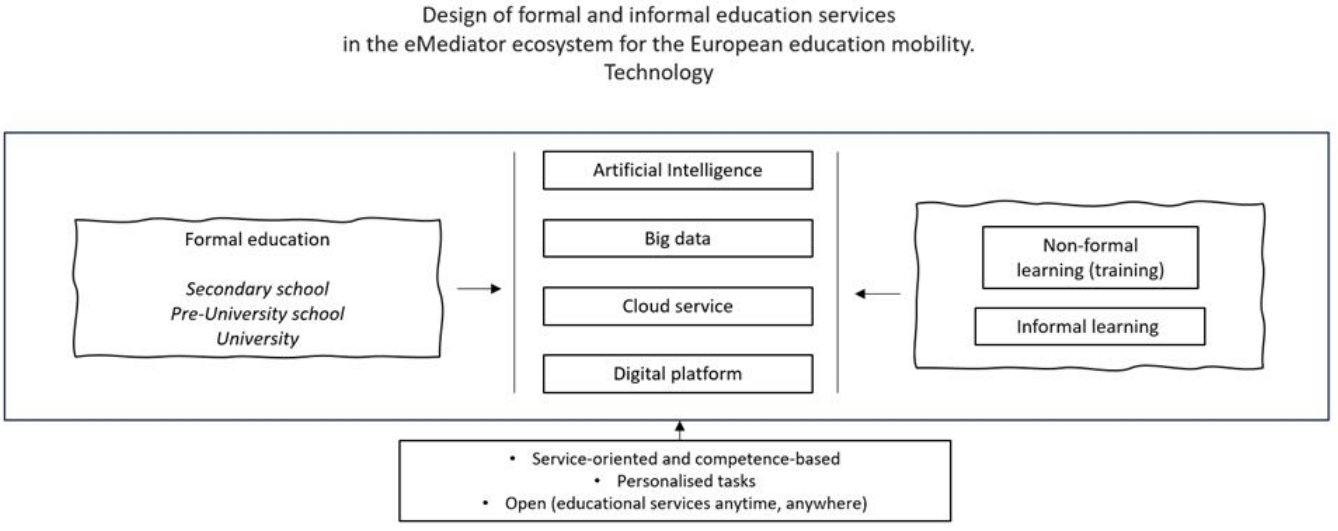


Figure 4. Formal and informal education services from the perspective of technology

To sum up, the presented designs of formal and formal education services focus on unique features for each category. The formal and informal education services aim to provide EU borderless online education mobility, which became a reality by joining the main education market players in one virtual space.

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LIST OF AUTHORS

1. Marcin Rojek (1.1.)
2. Małgorzata Gawlik-Kobylińska, Paweł Maciejewski (1.2.)

2 . A3.5 Development of the model of application, admission and enrolment (TSI)

2.1 Introduction

In today's fast-paced and interconnected world, education has transcended traditional boundaries and moved towards innovative digital platforms. The concept of "Mobile Education as a Service" (MEaaS) has emerged as a dynamic approach that leverages mobile technology and cloud-based solutions to provide flexible and accessible learning opportunities. This model enables individuals, whether students or working professionals, to access education and training services anytime and anywhere, breaking down the barriers of time, location, and physical mobility.

In line with the MEaaS approach, an e-learning platform is being developed to revolutionize the application, admission, and enrollment processes in education. This platform aims to provide a seamless and user-friendly experience for both learners and education providers. By implementing a comprehensive model for application, admission, and enrollment, this e-learning platform creates a digital ecosystem that connects aspiring learners with universities, training centers, and individual teachers.

The model of application, admission, and enrollment within this e-learning platform encompasses a range of components and functionalities. It streamlines the entire process, from initial application submission to course selection and enrollment confirmation. This model prioritizes user convenience, personalization, and efficient management of educational opportunities. Learners can explore a diverse range of courses and programs, submit applications electronically, and receive timely updates on their application status. Additionally, education providers can seamlessly manage admissions, evaluate applications, and facilitate smooth enrollment processes.

This description aims to provide a comprehensive overview of the model of application, admission, and enrollment within the e-learning platform, highlighting its significance in implementing the MEaaS approach. It will delve into the key components, functionalities, and benefits associated with this model. By embracing this innovative approach, the e-learning platform strives to redefine the educational landscape, making quality education accessible, convenient, and tailored to the needs of modern learners.

2.2 Model architecture of application, admission, and enrollment for MEaaS platform

This architecture provides a foundation for the development of an e-learning platform that supports application, admission, and enrollment processes based on the Mobile Education as a Service approach. It enables seamless interaction between users, efficient management of applications and admissions, and effective mapping of competencies to relevant courses.

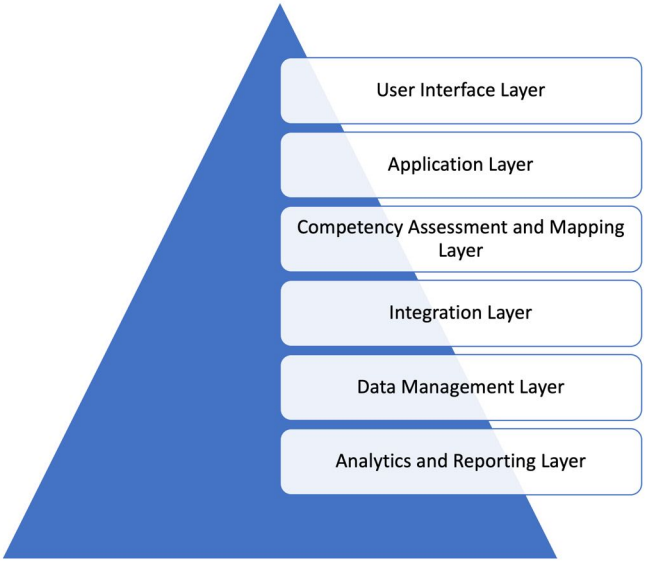

Figure 5. Model architecture of application, admission, and enrollment for MEaaS platform

This architecture includes the next main components (Fig.1):

1. User Interface Layer. This layer consists of the user-facing interfaces that facilitate the application, admission, and enrollment processes. It includes web and mobile applications that enable users, such as students, working professionals, universities, training centers, and individual teachers, to interact with the platform. The user interfaces should be intuitive, user-friendly, and accessible on various devices.
2. Application Layer. The application layer manages the logic and functionality required for the application, admission, and enrollment processes. It consists of the following components:
   - Registration and Authentication. This component allows users to create accounts, authenticate their identities, and manage their profiles.
   - Course Catalog. This component provides an organized catalog of available courses, including detailed descriptions, prerequisites, and associated competencies.
   - Application Management. This component handles the submission and processing of applications from students or professionals interested in enrolling in courses. It includes features such as application forms, document upload functionality, and application status tracking.
   - Admission Management. This component manages the evaluation and decision-making process for admitting applicants into specific courses or programs. It may include criteria assessment, applicant screening, and decision-making workflows.

- Enrollment Management. This component handles the enrollment process once applicants are admitted. It includes features like course selection, payment processing, and enrollment confirmation.

3. Competency Assessment and Mapping Layer. This layer focuses on assessing and mapping the competencies of the users. It includes components such as:
   - Competency Assessment. This component provides tools and assessments to evaluate the existing competencies of students or professionals.
   - Competency Mapping. This component maps the assessed competencies to the relevant courses or programs available on the platform. It ensures that users are matched with courses that align with their skill sets and learning goals.
4. Integration Layer. The integration layer facilitates communication and integration between the e-learning platform and external systems or services. It may include:
   - Integration with Education Institutions. This component allows integration with universities, training centers, or other educational institutions that offer courses on the platform. It enables data exchange, such as course availability, admission requirements, and enrollment data.
   - Integration with Payment Gateways. This component integrates with payment gateways to enable secure payment processing for course fees or other related transactions.
5. Data Management Layer. The data management layer handles the storage, retrieval, and management of data related to applications, admissions, enrollments, user profiles, competencies, and course information. It includes databases, data models, and data management systems that ensure the availability and security of data.
6. Analytics and Reporting Layer. This layer provides analytical capabilities and reporting functionalities to track and analyze data related to the application, admission, and enrollment processes. It allows administrators to monitor and evaluate system performance, user engagement, and other key metrics.

2.3 The main requirements for a model of application, admission, and enrollment for MEaaS platform

For the practical implementation of this model architecture, certain requirements must be met during its development, the main of which include the following (Fig.2).

Figure 6. The main requirements for a model of application, admission, and enrollment

1. User-Friendly Interface. The model should have an intuitive and user-friendly interface that allows easy navigation and interaction for all types of users, including students, working professionals, universities, training centers, and individual teachers. The interface should be responsive, accessible on different devices, and support multiple languages if necessary.
2. Registration and Authentication. The model should provide a seamless registration process for users, allowing them to create accounts, authenticate their identities, and manage their profiles. Strong security measures should be implemented to protect user data and privacy.
3. Course Catalog Management. The model should support a comprehensive and organized course catalog that includes detailed descriptions, prerequisites, learning outcomes, and associated competencies for each course or program. The catalog should be easily searchable, filterable, and regularly updated to reflect the latest offerings.
4. Application Management. The model should facilitate the submission and management of applications from prospective students or professionals. It should include features such as application forms, document upload functionality, and application status tracking. The model should also allow for efficient communication and notifications between applicants and administrators.
5. Admission Management. The model should support the evaluation and decision-making process for admitting applicants into specific courses or programs. It should enable the establishment of admission criteria, applicant screening, and decision workflows. It should provide administrators with tools to review and assess applications efficiently.
6. Enrollment Management. The model should streamline the enrollment process for admitted applicants. It should provide features such as course selection, payment processing, and enrollment confirmation. It

should also allow users to manage their enrollments, make changes if needed, and view their enrollment history.

7. Competency Assessment and Mapping. The model should include mechanisms to assess the competencies of users and map them to relevant courses or programs. It should provide tools for competency assessments, track learner progress, and suggest suitable courses based on the mapped competencies.
8. Integration Capabilities. The model should support integration with external systems or services, such as education institutions' databases, payment gateways, or learning management systems. This enables seamless data exchange, synchronization of course offerings and availability, and secure payment processing.
9. Data Management and Security. The model should ensure robust data management, including secure storage, retrieval, and management of user profiles, application data, competencies, and course information. Data privacy and security measures should be implemented to protect sensitive information.
10. Analytics and Reporting. The model should provide analytical capabilities and reporting functionalities to track and analyze data related to applications, admissions, enrollments, and user engagement. It should generate insightful reports and dashboards to aid administrators in monitoring system performance, identifying trends, and making data-driven decisions.

By fulfilling these requirements, the model can provide a robust and user-centric application, admission, and enrollment process for the e-learning platform, supporting the Mobile Education as a Service approach effectively.

Let's take a closer look at each of these requirements.

2.4 The main components for a user-friendly interface of the platform

By incorporating these components into the user interface, the platform can offer a user-friendly experience, making it easy for users to navigate, interact, and accomplish their desired tasks effectively. The user-friendly interface of the platform consists of the following main components (Fig. 3).

The brief description of each component for a user-friendly interface of the platform is presented in Table 1.

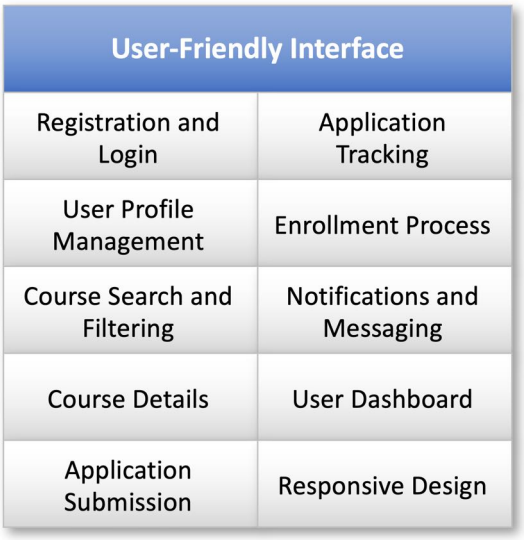

Figure 7. The main components for a user-friendly interface of the platform

Table 1. The brief description of each component for a user-friendly interface of the platform

The main components for a user-friendly interface of the platform	Brief description
Registration and Login	This component enables users to create new accounts by providing necessary information such as name, email address, and password. It should also provide an option for users to log in with existing credentials securely. Clear instructions and error handling should be implemented to guide users through the registration and login processes smoothly.
User Profile Management	This component allows users to manage their profiles, including updating personal information, uploading profile pictures, and setting preferences. It should provide an easy-to-use interface that allows users to modify and save their profile details effortlessly.
Course Search and Filtering	This component provides a search functionality that enables users to find courses or programs based on various criteria such as subject, keywords, level, or duration. It should include advanced filtering options to narrow down search results and help users quickly find relevant courses.
Course Details	This component displays detailed information about each course or program. It should include key details such as course description, learning objectives, prerequisites, instructors' profiles, and associated competencies. Visual aids

	like images, videos, or sample course materials can be included to enhance the understanding of the course content.
Application Submission	This component allows users to submit their applications for specific courses or programs. It should provide a clear and user-friendly form where applicants can enter relevant information and upload required documents. Progress indicators and validation checks should be implemented to ensure all necessary information is provided before submission.
Application Tracking	This component enables applicants to track the status of their applications. It should provide real-time updates on the progress of the application, such as submission received, under review, accepted, or rejected. Notifications and alerts should be sent to applicants when there are changes in their application status.
Enrollment Process	This component guides users through the enrollment process after their applications are accepted. It should display available courses for enrollment, allow users to select their preferred courses, and provide information on enrollment deadlines, payment methods, and any additional steps required for enrollment confirmation.
Notifications and Messaging	This component facilitates communication between users and the platform administrators. It should provide notifications about application updates, enrollment deadlines, or other important announcements. Users should also have the option to send messages to administrators or instructors for inquiries or support.
User Dashboard	This component offers users a centralized and personalized dashboard where they can access their application status, enrollment history, course progress, and relevant notifications. It should provide an overview of their activities and serve as a hub for managing their learning journey on the platform.
Responsive Design	This component ensures that the user interface is responsive and adaptable to different screen sizes and devices, including desktops, laptops, tablets, and mobile phones. It should provide a consistent and seamless user experience across various platforms, allowing users to access the platform conveniently from any device.

2.5 The main components for Registration and Authentication of this platform.

By incorporating these components into the Registration and Authentication process, the platform can provide a secure and user-friendly experience, allowing users to create and manage their accounts effectively while ensuring their privacy and account security.

The Registration and Authentication of the platform consists of the following main components (Fig.4).

The brief description of each component for Registration and Authentication is presented in Table 2.

Figure 8. The main components for Registration and Authentication

Table 2. The brief description of each component for for Registration and Authentication of the platform

The main components for a user-friendly interface of the platform	Brief description
Registration Form	This component allows new users to create an account by providing the necessary information such as name, email address, password, and any additional required fields. The registration form should be user-friendly, visually appealing, and include validation checks to ensure accurate and complete information is provided.
Account Verification	This component ensures the authenticity and security of user accounts. It may involve email verification, where users receive a verification link to their provided email address and need to click on it to confirm their account. This process helps prevent unauthorized access and ensures that users have access to

	the provided email address.
Login Form	This component enables registered users to log into their accounts securely. It should include fields for users to enter their email address or username and password. Additional security measures, such as two-factor authentication, can be implemented to enhance account security.
Social Media Authentication	This optional component allows users to register or log in to the platform using their existing social media accounts, such as Google, Facebook, or LinkedIn. It provides a convenient and streamlined registration and login process for users who prefer to use their social media credentials.
Password Recovery	This component provides a mechanism for users to recover or reset their passwords in case they forget them. It typically involves an email-based password reset process, where users receive a password reset link to their registered email address and can set a new password.
Account Settings	This component allows users to manage their account settings. It includes options to update personal information, change passwords, manage notification preferences, and link or unlink social media accounts if applicable.
Security Measures	This component ensures the security of user accounts and protects user data. It includes features such as password encryption, secure transmission of data using HTTPS protocol, and implementation of security best practices to prevent unauthorized access or data breaches.
Privacy and Data Protection	This component ensures the privacy and protection of user data in compliance with relevant data protection regulations. It includes measures such as obtaining user consent for data processing, providing transparent privacy policies, and implementing data storage and handling practices that prioritize user privacy.
User Roles and Permissions	This component manages user roles and permissions within the platform. It allows administrators to assign different roles to users (e.g., students, instructors, administrators) with varying levels of access and permissions based on their respective responsibilities and needs.
Single Sign-On (SSO)	This optional component allows users to log in to the platform using their existing credentials from other systems or platforms. SSO integration enables a seamless login experience, especially for users who already have accounts with affiliated institutions or services.

2.6 The main components for Course Catalog Management of the platform

By incorporating these components into Course Catalog Management, the platform can offer a comprehensive and user-friendly course discovery experience. Users can easily explore, search, and filter through the catalog, access detailed course information, and make informed decisions about their learning journey. The Course Catalog Management components play a vital role in providing a rich and informative interface for learners, instructors, and administrators.

The Course Catalog Management of the platform consists of the following main components (Fig.5).

The brief description of each component for Registration and Authentication is presented in Table 3.

Figure 9. The main components of the Course Catalog Management of the platform

Table 3. The brief description of each component of the Course Catalog Management of the platform

The main components for a user-friendly interface of the platform	Brief description
Course Listing	This component displays a comprehensive list of available courses or programs offered on the platform. It provides an overview of the courses, including titles, brief descriptions, and relevant metadata such as duration, level, and associated competencies.
Course Details	This component provides detailed information about each course or program in the catalog. It includes comprehensive descriptions, learning objectives, prerequisites, target audience, syllabus, assessment methods, and any additional

	resources or materials associated with the course. It may also include instructor profiles and ratings.
Search and Filtering	This component enables users to search for courses based on specific criteria such as subject, keywords, level, duration, or availability. It may also include advanced filtering options, allowing users to narrow down their search results based on specific preferences and requirements.
Sorting and Sorting Options	This component allows users to sort the course catalog based on various parameters such as popularity, ratings, duration, or start date. It provides sorting options to customize the display of courses according to users' preferences.
Categories and Tags	This component organizes courses into relevant categories or tags to facilitate easy navigation and browsing. Categories may be based on subjects, disciplines, or areas of specialization. Tags can include keywords or specific topics associated with the courses.
Course Recommendations	This optional component provides personalized course recommendations to users based on their preferences, past enrollments, or mapped competencies. It uses algorithms and user data analysis to suggest relevant courses that align with users' interests and learning goals.
Course Availability and Schedule	This component displays information about the availability of courses, including upcoming course sessions, enrollment periods, and start dates. It allows users to view course schedules and plan their learning accordingly.
Competency Mapping	This component indicates the competencies associated with each course or program. It provides information on the skills or knowledge that learners will gain upon completing the course. Users can review the competency mappings to understand the alignment between their learning goals and the course offerings.
Ratings and Reviews	This optional component allows users to provide ratings and reviews for courses they have completed. It enables users to share their feedback and experiences, helping others make informed decisions when selecting courses from the catalog.
Course Management	This component is for administrators and course providers. It enables them to add, edit, and manage course listings in the catalog. It includes features for course creation, updates, content management, and curriculum modifications.

2.7 The main components for Application Management of the platform

By incorporating these components into Application Management, the platform can streamline the application process, provide transparency to applicants, and enable efficient management and evaluation of applications. The components contribute to an organized and seamless experience for applicants, reviewers, and administrators involved in the application management workflow.

The Application Management of the platform consists of the following main components (Fig.6).

The brief description of each component for Registration and Authentication is presented in Table 4.

Figure 10. The main components of the Course Catalog Management of the platform

Table 4. The brief description of each component for Registration and Authentication of the platform

The main components for a user-friendly interface of the platform	Brief description
Application Form	This component provides an online form for users to submit their applications for specific courses or programs. The form collects essential information from applicants, including personal details, educational background, work experience (if applicable), and any additional information required for the application process.
Document Upload	This component allows applicants to upload supporting documents, such as transcripts, certificates, resumes, or recommendation letters, as part of their application. It should support file uploads in various formats and sizes, with appropriate validation checks to ensure the completeness and integrity of the uploaded documents.

Application Tracking Dashboard	This component provides a dashboard or interface for applicants to track the progress of their submitted applications. It displays the current status of the application, such as "Submitted," "Under Review," "Accepted," or "Rejected." Applicants can view the timeline of their application and any updates or notifications related to its status.
Application Status Notifications	This component enables the platform to send automated notifications or emails to applicants, keeping them informed about the progress and updates of their applications. Notifications can include confirmation of application receipt, updates on application review process, and final decision notifications.
Application Review Workflow	This component supports the workflow for reviewing and evaluating applications by designated reviewers or admissions officers. It includes features such as assigning applications to reviewers, tracking the status of reviews, and providing feedback or comments on applications.
Application Evaluation Criteria	This component defines the criteria or rubrics used for evaluating and assessing applications. It allows reviewers to score or rate applications based on predefined criteria such as academic performance, relevant experience, personal statements, or other specific requirements for admission.
Application Decision-making	This component facilitates the decision-making process for admitting or rejecting applications. It enables administrators or admissions officers to review the evaluation results, make decisions based on the criteria, and communicate the outcomes to applicants.
Communication and Correspondence	This component provides a means of communication between applicants and admissions officers or reviewers. It may include messaging features or discussion threads that allow applicants to ask questions, provide additional information, or seek clarification during the application review process.
Application Analytics and Reporting	This optional component enables administrators to generate reports and analytics related to the application management process. It may include metrics such as application volume, acceptance rates, demographic data, and other key performance indicators that help assess the effectiveness and efficiency of the application process.
Application Archive and Data Management	This component ensures the proper storage, organization, and management of application data. It includes secure databases or repositories where application information is stored for future reference, compliance, and reporting purposes.

2.8 The main components for Admission Management of the platform

By incorporating these components into Admission Management, the platform can streamline the admission process, ensure transparency and fairness in decision-making, and provide a smooth transition for admitted applicants to enroll in their desired courses. The components contribute to efficient and effective admission management, enhancing the overall user experience for applicants, admissions officers, and administrators involved in the process.

The Admission Management of the platform consists of the following main components (Fig.7).

The brief description of each component for Admission Management is presented in Table 5.

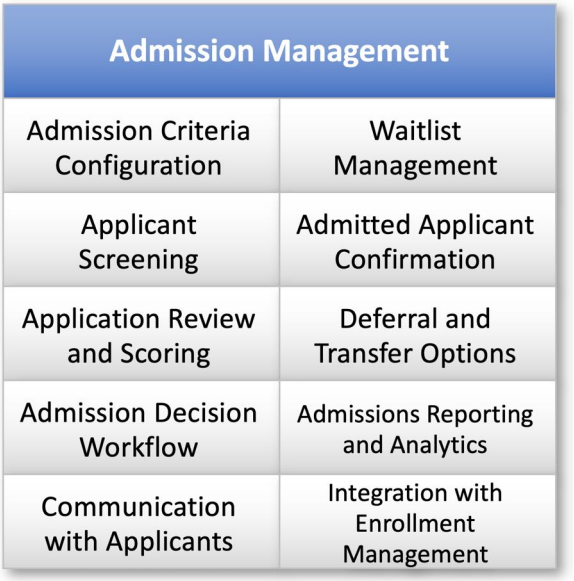

Figure 11. The main components of the Admission Management of the platform

Table 5. The brief description of each component for Admission Management of the platform

The main components for a user-friendly interface of the platform	Brief description
Admission Criteria Configuration	This component allows administrators to define and configure the admission criteria for each course or program. It includes parameters such as academic qualifications, work experience, prerequisite courses, language proficiency, or any other specific requirements for admission.
Applicant Screening	This component enables the screening and evaluation of applicants based on the defined admission criteria. It may involve automated or manual processes to review and assess the applicants' qualifications, documents, and submitted

	materials against the predefined criteria
Application Review and Scoring	This component provides a platform for admissions officers or reviewers to review and score the applications based on the established admission criteria. It allows reviewers to assess and rate applications using rubrics or scoring systems to ensure consistency and fairness in the evaluation process.
Admission Decision Workflow	This component facilitates the decision-making process for admitting applicants into specific courses or programs. It includes features such as assigning applications to decision-makers, tracking the status of decisions, and providing a workflow for collaboration and consensus among decision-makers.
Communication with Applicants	This component enables administrators or admissions officers to communicate with applicants throughout the admission process. It includes features for sending notifications, updates, or requests for additional information, as well as providing timely and personalized communication regarding the admission decisions.
Waitlist Management	This component handles the management of waitlisted applicants. It allows administrators to prioritize and manage waitlisted applicants based on available spots or subsequent admission decisions. Applicants on the waitlist can be informed about their status and given instructions on further actions.
Admitted Applicant Confirmation	This component facilitates the confirmation process for admitted applicants. It allows them to accept or decline the admission offer within a specified timeframe. It may include features for submitting acceptance forms, making initial payments, or providing necessary documentation for enrollment.
Deferral and Transfer Options	This component provides options for applicants to request deferral of admission to a future term or to transfer their admission to a different course or program within the platform. It includes a process for evaluating and managing deferral or transfer requests from applicants.
Admissions Reporting and Analytics	This optional component generates reports and analytics related to the admission process. It provides insights into admission trends, applicant demographics, acceptance rates, and other key metrics that help monitor and evaluate the effectiveness of the admission management process.
Integration with Enrollment Management	This component integrates the admission management process with the enrollment management system. It ensures a seamless transition from admission to enrollment, allowing admitted applicants to easily select their desired courses, make payments, and complete the enrollment process.

2.9 The main components for Enrollment Management of the platform

By incorporating these components into Enrollment Management, the platform can provide a streamlined and efficient process for students to confirm their enrollment, select courses, make payments, and manage their enrollment status. The components contribute to a smooth and user-friendly enrollment experience, supporting students, instructors, and administrators in effectively managing the enrollment process.

The Enrollment Management of the platform consists of the following main components (Fig.8).

The brief description of each component for Enrollment Management is presented in Table 6.

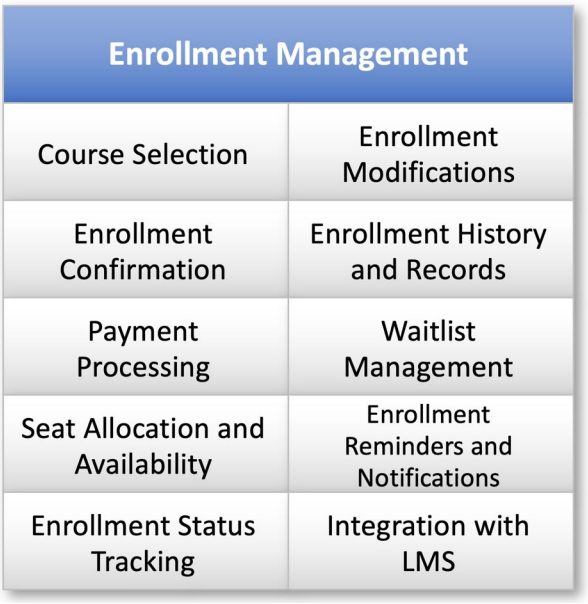

Figure 12. The main components of the Enrollment Management of the platform

Table 6. The brief description of each component for Enrollment Management of the platform

The main components for a user-friendly interface of the platform	Brief description
Course Selection	This component allows admitted applicants to browse and select the courses or programs they wish to enroll in. It provides a user-friendly interface that displays available courses, along with relevant details such as schedules, instructors, and any prerequisites or restrictions.
Enrollment Confirmation	This component enables admitted applicants to confirm their enrollment in the selected courses or programs. It includes features such as enrollment acceptance forms, payment options, and submission of necessary documents or agreements.

Payment Processing	This component facilitates the secure processing of course fees or any other relevant payments associated with the enrollment process. It supports various payment methods, such as credit cards, bank transfers, or online payment gateways, and ensures the confidentiality and integrity of financial transactions.
Seat Allocation and Availability	This component manages the allocation of available seats in courses or programs. It allows applicants to see the number of seats remaining in each course and provides real-time updates on seat availability. If necessary, it may include a waitlist management feature to handle oversubscribed courses.
Enrollment Status Tracking	This component enables applicants to track the status of their enrollment process. It provides information on whether enrollment has been successfully confirmed, payment has been received, and any additional steps required to complete the process. Applicants can view their enrollment status and receive notifications or reminders for pending actions.
Enrollment Modifications	This component allows enrolled students to make modifications to their course selections or schedules, such as adding or dropping courses, changing sections, or adjusting class timings. It includes features for updating course selections and managing enrollment changes within defined timelines and policies.
Enrollment History and Records	This component maintains a record of the enrollment history for each student. It includes information on past enrollments, completed courses, grades, and any related documentation. This data can be accessed by students, instructors, or administrators for reference and academic purposes.
Waitlist Management	This component handles the management of waitlisted applicants who are awaiting available spots in their desired courses. It automatically manages seat allocations based on changes in enrollment and provides notifications to waitlisted students when spots become available.
Enrollment Reminders and Notifications	This component sends automated reminders and notifications to students regarding enrollment deadlines, payment due dates, or any other relevant updates. It ensures that students are informed and guided throughout the enrollment process.
Integration with Learning Management System (LMS)	This component integrates the enrollment management process with the learning management system. It ensures seamless synchronization of enrolled students' information, course access, grades, and other relevant data between the enrollment system and the LMS.

2.10 The main components for Competency Assessment and Mapping of the platform

By incorporating these components into Competency Assessment and Mapping, the platform can effectively evaluate learners' competencies, match them with appropriate courses, and provide personalized learning pathways for competency development. The components contribute to a learner-centric approach that enhances the effectiveness of the educational experience and supports learners in acquiring and refining their desired competencies.

The Competency Assessment and Mapping of the platform consists of the following main components (Fig.9).

The brief description of each component for Competency Assessment and Mapping is presented in Table 7.

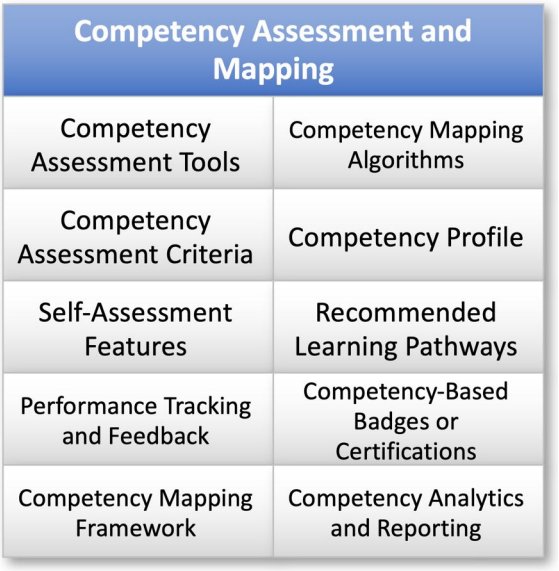

Figure 13. The main components of the Competency Assessment and Mapping of the platform

Table 7. The brief description of each component for Competency Assessment and Mapping of the platform

The main components for a user-friendly interface of the platform	Brief description
Competency Assessment Tools	This component provides tools and assessments for evaluating the competencies of learners. It may include quizzes, tests, projects, or other interactive activities designed to assess learners' knowledge, skills, and abilities in specific domains or subject areas.
Competency Assessment Criteria	This component defines the criteria and rubrics used to assess learners' competencies. It includes clear guidelines and standards for evaluating learners' performance and determining their proficiency in different competencies.

Self-Assessment Features	This component allows learners to perform self-assessments of their competencies. It may include questionnaires, self-evaluation forms, or reflective exercises that enable learners to reflect on their own skills and knowledge in relation to the defined competencies.
Performance Tracking and Feedback	This component tracks learners' performance and provides feedback based on their competency assessments. It may include automated scoring, personalized feedback, and suggestions for improvement to support learners' ongoing development.
Competency Mapping Framework	This component establishes a framework for mapping the assessed competencies to the relevant courses or programs available on the platform. It ensures that learners are matched with courses that align with their current skill sets, learning goals, and areas for improvement.
Competency Mapping Algorithms	This component utilizes algorithms to match learners' assessed competencies with the appropriate courses or programs. It may consider factors such as competency levels, prerequisites, learning objectives, and the desired progression of skills when suggesting suitable courses for learners.
Competency Profile	This component allows learners to view and manage their competency profiles. It displays their assessed competencies, levels of proficiency, and any gaps or areas for development. Learners can track their progress, set goals, and identify the courses or resources that can help them enhance their competencies.
Recommended Learning Pathways	This component suggests personalized learning pathways or sequences of courses based on learners' assessed competencies and desired learning goals. It provides guidance on the most suitable courses to take for further development and mastery of specific competencies.
Competency-Based Badges or Certifications	This component awards digital badges or certifications to learners upon successfully demonstrating competence in specific areas. These badges or certifications serve as credentials that validate learners' achievement and proficiency in relevant competencies.
Competency Analytics and Reporting	This optional component generates analytics and reports related to learners' competencies. It provides insights into learners' strengths, areas for improvement, and overall competency development. These reports can assist learners, instructors, and administrators in monitoring progress, identifying trends, and making data-driven decisions.

2.11 The main components for Integration Capabilities of the platform

By incorporating these integration capabilities, the platform can seamlessly connect with external systems, services, and resources, enhancing functionality, data exchange, and collaboration. The components contribute to a more efficient and interconnected educational ecosystem, providing users with a comprehensive and integrated learning experience.

The Integration Capabilities of the platform consists of the following main components (Fig.10).

The brief description of each component for Integration Capabilities is presented in Table 8.

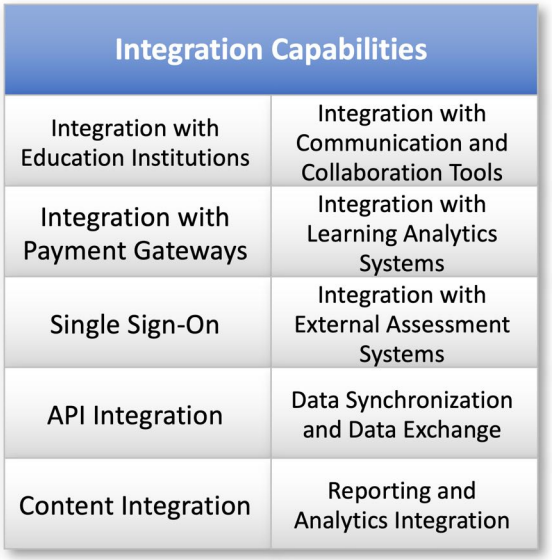

Figure 14. The main components of the for Integration Capabilities of the platform

Table 8. The brief description of each component for Integration Capabilities of the platform

The main components for a user-friendly interface of the platform	Brief description
Integration with Education Institutions	This component enables integration with external education institutions, such as universities, training centers, or other educational providers. It facilitates data exchange and synchronization of information, including course offerings, admission requirements, academic calendars, and student data. It allows for seamless collaboration and partnership between the platform and external institutions.
Integration with Payment Gateways	This component integrates the platform with payment gateways to enable secure and streamlined payment processing. It supports various payment methods, such as credit cards, bank transfers, or digital wallets, providing users with convenient options for course

	fee payments and other related transactions.
Single Sign-On	This component allows users to log in to the platform using their existing credentials from other systems or platforms. It enables a seamless user experience by eliminating the need for multiple logins and providing a unified authentication process.
API Integration	This component provides application programming interfaces (APIs) that allow the platform to integrate with other systems, services, or applications. It enables data exchange, functionality sharing, and interoperability with external systems, such as learning management systems, student information systems, or content management systems.
Content Integration	This component facilitates the integration of external educational content or resources into the platform. It allows for the inclusion of multimedia materials, e-books, videos, or interactive content from external providers or content repositories, enriching the learning experience for users.
Integration with Communication and Collaboration Tools	This component enables integration with communication and collaboration tools, such as email systems, messaging platforms, or video conferencing tools. It facilitates seamless communication and collaboration among learners, instructors, and administrators, promoting interactive and engaging learning experiences.
Integration with Learning Analytics Systems	This component integrates the platform with learning analytics systems or data analytics tools. It allows for the collection, analysis, and visualization of learning data, enabling administrators and instructors to gain insights into learner performance, engagement, and progress. This integration supports data-driven decision-making and personalized learning experiences.
Integration with External Assessment Systems	This component integrates the platform with external assessment systems or tools. It allows for the integration of assessments, quizzes, or exams from external providers, providing a wider range of assessment options and ensuring compatibility with established assessment practices.
Data Synchronization and Data Exchange	This component ensures the synchronization and exchange of data between the platform and external systems. It enables the seamless transfer of information such as user profiles, course updates, enrollment data, grades, or certification records, maintaining data consistency across systems.
Reporting and Analytics Integration	This component integrates the platform with reporting and analytics tools to enhance reporting capabilities and generate comprehensive insights. It allows administrators and instructors to access advanced reporting features, visualizations, and dashboards, enabling them to monitor key metrics, track performance, and make data-informed decisions.

2.12 The main components for Data Management and Security of the platform

By incorporating these components, the platform can ensure the secure and responsible management of user data, protect data privacy, and maintain the integrity and availability of the platform. The components contribute to a robust and reliable data management and security framework, instilling user confidence and trust in the platform's handling of their data.

The Data Management and Security of the platform consists of the following main components (Fig.11).

The brief description of each component for Data Management and Security is presented in Table 9.

Figure 15. The main components of the for Data Management and Security of the platform

Table 9. The brief description of each component for Data Management and Security of the platform

The main components for a user-friendly interface of the platform	Brief description
Data Storage and Database Management	This component manages the storage and organization of data related to user profiles, course information, enrollment records, assessment results, and other relevant data. It includes databases or data management systems that ensure efficient data storage, retrieval, and scalability.
Data Privacy and Consent Management	This component ensures compliance with data protection regulations and manages user privacy. It includes features for obtaining user consent for data processing, maintaining transparent privacy policies, and allowing users to manage their privacy settings and preferences.
User Authentication and Access Control	This component manages user authentication, ensuring that only authorized individuals can access the platform and its data. It includes features such as

	secure login mechanisms, password encryption, and role-based access control to restrict access to sensitive data based on user roles and permissions.
Data Encryption and Secure Transmission	This component employs encryption techniques to protect sensitive data, both during storage and transmission. It ensures that data is encrypted when stored in databases or transmitted over networks, preventing unauthorized access and maintaining data integrity.
Data Backup and Disaster Recovery	This component implements regular data backups and disaster recovery measures to ensure the availability and continuity of the platform. It includes scheduled backups, redundant storage systems, and procedures to restore data in the event of system failures or data loss.
Audit Logs and Activity Monitoring	This component maintains audit logs and monitors user activities within the platform. It records user actions, system events, and access logs to detect and prevent unauthorized activities, and assists in troubleshooting and security incident investigations.
Data Retention and Deletion	This component defines data retention policies and ensures the proper deletion of data when it is no longer needed or requested by users. It includes mechanisms to securely delete user data from the platform and related systems in compliance with applicable data protection regulations.
Data Integrity and Quality Assurance	This component ensures the integrity and quality of data stored in the platform. It includes data validation checks, error handling mechanisms, and data cleansing processes to maintain accurate and reliable data throughout the system.
Security Assessments and Vulnerability Management	This component conducts regular security assessments and vulnerability scans to identify and address potential security weaknesses. It includes measures such as penetration testing, vulnerability management, and security patches to protect the platform from potential threats and vulnerabilities.
Compliance and Legal Considerations	This component addresses compliance with relevant data protection regulations, such as the General Data Protection Regulation (GDPR) or other local privacy laws. It ensures that the platform adheres to legal requirements regarding data management, privacy, and user rights.

2.13 The main components for Analytics and Reporting of the platform

By incorporating these components, the platform can provide robust analytics and reporting capabilities, empowering administrators, instructors, and education providers with actionable insights and data-driven decision-making. The components contribute to monitoring platform performance, optimizing learning experiences, and enhancing the overall effectiveness of the educational ecosystem.

The Analytics and Reporting of the platform consists of the following main components (Fig.12).

The brief description of each component for Analytics and Reporting is presented in Table 10.

Figure 16. The main components of the for Analytics and Reporting of the platform

Table 10. The brief description of each component for Analytics and Reporting of the platform

The main components for a user-friendly interface of the platform	Brief description
Data Collection and Aggregation	This component collects and aggregates relevant data from various sources within the platform. It includes data on user activities, course progress, assessment results, enrollment statistics, and other key metrics.
Data Analysis and Processing	This component processes the collected data to derive meaningful insights and analytics. It involves techniques such as data mining, statistical analysis, machine learning, or predictive modeling to extract patterns, trends, and correlations from the data.
Dashboard and Visualization	This component presents the analyzed data in visual formats such as charts, graphs, or interactive dashboards. It provides users, such as administrators, instructors, or learners, with a clear and intuitive interface to view and explore

	the generated insights.
Key Performance Indicators	This component defines and tracks key performance indicators relevant to the platform's goals and objectives. It includes metrics such as enrollment rates, course completion rates, learner engagement, assessment outcomes, or learner satisfaction, providing a holistic view of the platform's performance.
Customizable Reports	This component allows users to generate customizable reports based on their specific requirements. It includes features to select desired data parameters, apply filters, and choose report formats to generate tailored reports for different stakeholders, such as administrators, instructors, or education providers.
Predictive Analytics	This component utilizes predictive modeling techniques to forecast future trends, learner behaviors, or outcomes. It can help identify at-risk learners, recommend personalized learning paths, or provide early intervention strategies to improve learner success and retention.
Learning Analytics	This component focuses on analyzing data related to learner performance, engagement, and progress. It includes metrics such as time spent on courses, completion rates, assessment scores, or learner interactions. Learning analytics helps identify areas for improvement, optimize course design, and personalize learning experiences.
Administrative Analytics	This component provides analytics and insights for administrators and education providers. It includes metrics related to enrollment patterns, resource allocation, revenue generation, or course popularity. Administrative analytics supports decision-making, resource planning, and strategic initiatives within the platform.
Real-time Analytics and Notifications	This component offers real-time analytics and notifications to provide timely insights and alerts. It enables administrators or instructors to monitor critical metrics, receive notifications about unusual activities, or track specific events as they happen within the platform.
Integration with External Analytics Tools	This component allows integration with external analytics tools or business intelligence platforms. It enables data exchange, synchronization, and analysis across multiple systems, supporting comprehensive reporting and advanced analytics capabilities.

2.14 Conclusion

The model of application, admission, and enrollment within the e-learning platform, embracing the concept of "Mobile Education as a Service", presents a transformative approach to education in the digital era. By leveraging mobile technology and cloud-based solutions, this model revolutionizes the way learners access educational opportunities, breaking down barriers of time, location, and physical mobility.

Through the implementation of this model, the e-learning platform offers a seamless and user-friendly experience for learners and education providers alike. It streamlines the entire process, from application submission to course selection and enrollment confirmation, emphasizing convenience, personalization, and efficiency. Learners can explore a wide range of courses, submit applications electronically, and track their application status in real-time. Education providers can efficiently manage admissions, evaluate applications, and facilitate smooth enrollment processes.

The MEaaS approach implemented by this e-learning platform holds great potential for transforming education. It empowers individuals, whether students or working professionals, to pursue lifelong learning, acquire new skills, and enhance their knowledge base. The model enables access to educational opportunities anytime, anywhere, enabling learners to fit education into their busy schedules and cater to their specific learning needs.

By embracing MEaaS, the e-learning platform strives to make quality education accessible, flexible, and personalized. It enables learners to overcome traditional barriers to education, fostering a culture of continuous learning and professional development. Additionally, education providers benefit from a streamlined and efficient process for managing applications and enrollments, facilitating greater student engagement and satisfaction.

In conclusion, the model of application, admission, and enrollment within the e-learning platform, driven by the MEaaS concept, represents a significant advancement in education. It empowers learners, transforms education delivery, and embraces the digital transformation of the learning landscape. By embracing this model, the e-learning platform is poised to contribute to the ongoing evolution of education, equipping individuals with the skills and knowledge necessary to thrive in a rapidly changing world.

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LIST OF AUTHORS

1. Boris Misnevs
2. Igor Kabashkin
3. Olga Zervina

3 . A4.5 Development of the model for job finding and graduate placement (UMU)

The purpose of this work is to set the ground for the development of a multidisciplinary framework to handle the complexity and difficulties experienced by graduates and job seekers when they enter the labour market. This framework integrates several components, including career counseling, competence evaluation, networking opportunities, and job search algorithms. Individuals can find their talents, explore career options, and match their competences and objectives with appropriate job possibilities with the help of career counseling. Assessing people's competences, finding areas for growth, and providing targeted training or development courses to boost their employability are all made possible through capabilities evaluation. Additionally, the framework acknowledges the value of networking in the job search procedure. It makes it easier to organize networking events, mentoring programs, and partnerships with industry leaders, allowing people to expand their professional networks and gain access to previously untapped job opportunities. Effective job matching is also made possible by the use of cutting-edge algorithms and technology, which take into account elements like competence, experience, sectoral preferences, and labour market trends. The adoption of this framework seeks to speed up the job search procedure and provide a more seamless entry of graduates into the workforce. It emphasizes the need of taking a proactive approach to career development, giving people the information they need to make wise decisions and putting them in touch with chances to work in fields they are interested in. The framework's ultimate goal is to streamline the graduate job search and placement process, fostering effective career outcomes and boosting both personal and societal progress and prosperity.

3.1 Introduction

Job finding and graduate placement are critical aspects of the transition from education to employment for individuals entering the workforce (Patton, Raniti, & Reavley, 2021). The process of securing suitable employment opportunities is often challenging, requiring individuals to navigate a complex and competitive job market (Zheng, Pan, & Liu, 2021). Similarly, graduates face unique challenges as they seek to apply their newly acquired knowledge and skills in real-world professional settings (Huang, Hwang, & Jong, 2022). The development of effective models and strategies for job finding and graduate placement is essential to facilitate successful career outcomes and bridge the gap between education and employment (Dixon et al., 2023).

In recent years, the landscape of job finding and graduate placement has witnessed significant changes. Rapid advancements in technology, evolving industry demands, and shifting economic conditions have contributed to a dynamic and ever-changing job market (Glass, Takasaki, Sassler, & Parker, 2023). Consequently, individuals

and educational institutions need to adapt and develop innovative approaches to address the evolving needs and demands of employers and job seekers (Arendt, Gałecka-Burdziak, Núñez, Pater, & Usabiaga, 2023).

One key aspect of job finding and graduate placement is career counseling and guidance (Bimrose et al., 2019). Career counselors play a vital role in assisting individuals in exploring various career options, identifying their strengths and interests, and aligning them with suitable employment opportunities. They provide valuable insights and advice, helping individuals make informed decisions regarding their career paths and development.

Competence assessment also plays a crucial role in job finding and graduate placement (Fousiani, Sypes, & Armenta, 2023; Guillaume, Houé, & Grabot, 2014). Employers seek candidates with a diverse range of skills that align with their organizational needs. Graduates need to assess their skills and identify areas for improvement to enhance their employability. Skill development programs, vocational training, and internships can aid graduates in acquiring the necessary skills and experience to meet industry expectations.

Furthermore, networking has emerged as a vital component in the job finding process (Galbis, Wolff, & Herault, 2020; Jahn & Neugart, 2020). Building professional connections and expanding networks can provide individuals with valuable insights, mentorship, and access to hidden job opportunities. Networking events, career fairs, and online platforms have become indispensable tools for job seekers and graduates to connect with potential employers and industry professionals.

Advancements in technology and the rise of digital platforms have also transformed the job finding and graduate placement landscape (Wesche & Sonderegger, 2021). Online job portals, professional networking sites, and applicant tracking systems have revolutionized the way individuals search for employment and connect with employers. Artificial intelligence (AI) and machine learning algorithms have enabled more efficient and personalized job matching, taking into account individual preferences, qualifications, and job market trends (Prentice, Wong, & Lin, 2023).

To address the complexities and challenges of job finding and graduate placement, the development of comprehensive models and strategies is crucial. These models should encompass a range of elements, including career counseling, competence assessment, networking opportunities, and advanced job matching algorithms. By integrating these components, individuals can benefit from a holistic and tailored approach to their job search, increasing their chances of securing meaningful employment opportunities.

The significance of effective job finding and graduate placement extends beyond individual success. A well-functioning job market and successful transition from education to employment contribute to overall economic growth and social well-being (Dinopoulos, Grieben, & Şener, 2023). By ensuring that individuals are placed in positions that align with their skills and aspirations, society can harness their full potential and drive innovation and productivity (Zangara, Cosma, & Filice, 2023).

In summary, job finding and graduate placement are essential processes that require careful attention and strategic approaches. By providing career counseling, facilitating competence assessment, promoting

networking opportunities, and leveraging advanced technologies, individuals can navigate the job market with confidence and secure rewarding employment opportunities. The development of comprehensive models and strategies is pivotal in bridging the gap between education and employment, enabling individuals to embark on successful and fulfilling careers. Moreover, the outcomes of effective job finding and graduate placement extend to societal and economic benefits, making it an area of paramount importance for individuals, educational institutions, employers, and policymakers alike.

3.2 Job Search Algorithms

The search for employment has undergone a significant transformation in recent years, thanks to the emergence of job search algorithms. These tools, fueled by advanced technologies such as AI and machine learning, have revolutionized the way individuals find job opportunities that align with their competences, qualifications, and career aspirations.

- **Evolution of Job Search Methods**

Traditionally, job seekers relied on conventional methods such as browsing classified ads in newspapers, attending job fairs, or leveraging personal connections to find employment opportunities. These methods were often time-consuming, limited in scope, and lacked the personalized approach that modern job seekers desire. However, with the rise of the internet and the proliferation of online job platforms, job search methods underwent a paradigm shift.

- **The Emergence of Job Search Algorithms**

Job search algorithms, also known as job matching algorithms, have emerged as a powerful tool in the digital age. These algorithms leverage vast amounts of data, including job postings, resumes, user preferences, and historical job seeker-employer interactions, to provide personalized job recommendations. By analyzing this data and employing various computational techniques, job search algorithms significantly enhance the efficiency and effectiveness of the job search process.

- **How Job Search Algorithms Work**

Job search algorithms utilize a combination of natural language processing, machine learning, and predictive analytics to match job seekers with suitable job openings. These algorithms process job descriptions, resumes, and user preferences to identify relevant keywords, competences, and qualifications. By considering factors such as location, experience level, industry, and salary expectations, job search algorithms generate a list of recommended job opportunities for each individual user.

- **Personalized Job Recommendations**

One of the key advantages of job search algorithms is the ability to provide personalized job recommendations. Traditional job search methods often resulted in information overload, with job seekers sifting through numerous irrelevant listings. Job search algorithms address this issue by narrowing down the options and

presenting job seekers with highly relevant opportunities tailored to specific needs. This personalized approach saves time and effort for job seekers, enabling them to focus on the most promising prospects.

- **Enhanced Efficiency for Employers**

Job search algorithms also offer significant benefits to employers. By using algorithms to pre-screen job applications and match them with the most suitable candidates, employers can streamline their recruitments. This results in reduced time-to-hire, increased efficiency in candidate selection, and improved quality of hires. Additionally, algorithms can assist employers in identifying passive job seekers who may not actively search for jobs but possess the desired qualifications.

- **Overcoming Bias in Hiring**

Another crucial aspect of job search algorithms is their potential to mitigate bias in the hiring process. Traditional hiring methods often suffer from unconscious biases that can lead to unfair and discriminatory practices. Job search algorithms, on the other hand, rely on objective data and predefined criteria, minimizing the influence of biases related to factors such as gender, race, or age. This objective approach contributes to more inclusive and equitable hiring practices.

- **Continuous Learning and Improvement**

Job search algorithms employ machine learning techniques to continuously learn and improve their performance. Through user feedback, job seeker-employer interactions, and data analysis, algorithms gain insights into the effectiveness of their recommendations. This feedback loop allows algorithms to adapt to changing job market dynamics, refine their matching capabilities, and provide increasingly accurate and relevant job recommendations over time.

- **Challenges and Ethical Considerations**

While job search algorithms offer numerous benefits, they also present challenges and ethical considerations. Privacy concerns related to the collection and use of personal data, algorithmic transparency, and potential biases in algorithmic decision-making require careful attention. Striking a balance between utilizing the power of algorithms and ensuring fairness, privacy, and transparency is essential to build trust in the job search process.

- **The Future of Job Search Algorithms**

The future of job search algorithms looks promising, with advancements in technology and data analytics continuing to drive innovation in the field. As algorithms become more sophisticated, they will incorporate additional factors such as soft skills, cultural fit, and career development opportunities into their matching processes. Furthermore, the integration of emerging technologies like natural language processing and virtual reality may further enhance the job search experience.

3.3 Artificial Intelligence in Recruitment

This work focuses on the role of AI in recruitment, given its significant impact on job search. Notably, several figures demonstrate the extent of this revolution. As per a survey conducted by LinkedIn, 73% of talent acquisition professionals reported utilizing AI-powered recruitment tools and services within their hiring processes (business.linkedin.com/talent-solutions/global-talent-trends). Moreover, a study by PwC revealed that AI has the potential to contribute $15.7 trillion to the global economy by 2030, with recruitment being among the sectors benefiting from AI implementation (pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html). A survey conducted by Korn Ferry found that 63% of talent acquisition professionals acknowledged the transformative impact of AI on recruitment, enhancing efficiency and effectiveness in the process (kornferry.com/about-us//press/korn-ferry-global-survey-artificial-intelligence-reshaping-the-role-of-the-recruiter). Additionally, a survey by CareerBuilder indicated that 55% of job seekers believe AI will play a significant role in shaping the future of job search and recruitment (careerimprovement.club/blog/ai-job-search-statistics). These statistics highlight the increasing adoption of AI algorithms for objective assessment of candidates' competences and qualifications. These algorithms analyze CVs, online profiles, and other data sources to match candidates with job requirements, thereby streamlining candidate screening and shortlisting processes. Prominent organizations such as IBM have embraced AI-powered recruitment platforms to efficiently manage high volumes of applications and identify the most suitable candidates.

3.4 OpenAI

OpenAI is an organization that focuses on the development of AI technologies. They are actively engaged in cutting-edge research in several domains including machine learning, natural language processing, computer vision, and robotics. Their notable contributions lie in the creation of innovative models and algorithms, with the Generative Pre-trained Transformer (GPT) series being one of their most prominent achievements. Transformers is a type of advanced computer model, and have the capability to analyze words and sentences, enabling computers to comprehend the meaning and context of human language. These models aim to enhance computers' understanding and generation of human-like language, proving valuable for tasks such as translation, chatbots, and text analysis. GPT-3, being one of OpenAI's largest and most powerful language models, undergoes extensive training using vast amounts of data from diverse sources such as books and websites to grasp language patterns and relationships. As a result, these models can provide coherent and contextually relevant responses across a wide range of queries and prompts.

The company is dedicated to the ideals of trustworthiness, openness, and collaboration. They place a strong emphasis on the responsible and ethical use of AI technology and support laws and procedures that guarantee its advantages are widely shared. They have also taken action to reduce any hazards related to the advancement of AI since they understand the need of long-term safety measures. Additionally, OpenAI has created a number

of tools and APIs that let programmers and companies use its AI technologies. These include access to pre-trained models, machine learning frameworks, and APIs for language processing. OpenAI hopes to democratise access to cutting-edge AI capabilities and promote innovation across multiple industries by making these resources available.

3.5 Validation of the Competence Model

The work carried out during this period is rooted in a well-established competence model that has been proposed and developed by the authors. To ensure its accuracy and effectiveness, the model underwent a validation process, including a basic usage scenario in which examples were employed to explain how to use it.

During the validation stage, a group of experts were engaged to review and evaluate the competence model. Their expertise and insights allowed to assess the model's comprehensiveness, relevance, and alignment with academic and professional competences. Through in-depth discussions and iterative feedback loops among the authors, the model was refined to ensure its robustness and applicability. This validation process provided a crucial opportunity to test the competence model in a controlled setting, allowing experts to assess its performance and provide valuable input. The validation allowed for the identification of any potential gaps, inconsistencies, or areas for improvement, which were promptly addressed to enhance the model's accuracy and reliability.

During the validation process, a survey was conducted to gather the opinions of participants regarding the competence model (available at: forms.gle/bENymrMMMbaR5WgS6). This survey was designed based on the Method Evaluation Model (MEM), a theoretical framework for assessing the effectiveness of information systems design methods (Moody, 2001). The survey questions were categorized into four main sections: (1) perceived utility, (2) perceived ease of use, (3) attitude towards use, and (4) intention to use. Some of the survey's results are depicted in Figure 1. Additionally, open-ended text fields were provided in the survey for additional feedback to the authors. The following are some of the most significant comments received:

1) Cultural competences or social competences? Or socio-cultural skills?

Although the competence model does not devote a specific section to cultural/social/socio-cultural competences. However, soft skills could include those covering aspects such as language, codes of conduct, customs, etc.

2) Credits, it is not a competence trait.

Even if it is not a competence trait it is part of the academic learning process. Credits reflect the number of hours needed to acquire a competence and can be a benchmark of a competence's complexity.

3) I don't feel "Pedagogical Knowledge".

This section in the model is intended to reflect all kinds of knowledge that an individual has to explain and transmit efficiently concepts of any kind to others.

4) It is not clear how flexible it is.

A competence should be reflected in the model at least by its ID, title and description. This is the basic unit of information that can be extended with the other attributes provided by the model.

Figure 17. Survey results

This competence model serves as a fundamental framework that defines and organizes the competences required for any particular domain or discipline. It provides a structured approach to understanding and assessing competences, enabling a systematic analysis and evaluation of individuals' capabilities.

3.6 Artificial Intelligence in the Competence Model

It is important to highlight that the model serves a dual purpose beyond storing academic and professional competences. Firstly, it aims to facilitate the selection of courses for Mobility in Education as a Service (MEaaS). As a way of example, students interested in mobility may pursue their academic career at several universities, while maintaining the coherence of their studies on the basis of a set of established competences. Participation in several mobility plans such as Socrates/Erasmus+, German Academic Exchange Service (in German Deutscher Akademischer Austauschdienst, DAAD), or the Fulbright program, may be boosted as academic objectives could be aligned with competences when choosing the courses to be taken. Secondly, the competence model aims to establish a connection between the academic and professional realms based on competences. The objective is to enhance accuracy in job searching by addressing the imprecisions that may arise in the labour market during candidate selection processes.

In order to cover the aforementioned objectives, two main functionalities were built with IA. These are the following ones:

- **Extraction:** this feature enables the automatic downloading of competences from free text, which can save time and effort for both educators and employers when inputting competences into the system. Additionally, it ensures that the model remains continuously updated with the latest requirements of any particular academic/professional field.

This functionality was previously explored using AI. In particular, a language model was trained to detect whether a statement was a competence or not, with the aim of subsequently populating the model with competences. A dataset with over 6,000 competences extracted from prestigious universities in Computer Science was used for training. As a result, the accuracy in the detection of competences achieved a success rate higher than 99% (see deliverable 3.A.4.4).

- **Matching:** offers a similarity index that compares two sets of competences. This feature is a powerful tool for recruiters and employers within the competence model as it allows them to determine whether a competence required in a job offer is included in the competences listed in a set of curricula. By doing so, it eliminates the uncertainty and inaccuracies commonly encountered in traditional recruitment processes, ensuring a more precise and efficient alignment between candidates and job criteria.

This functionality was also explored previously but by visual inspection and without using AI mechanisms. In particular, each competence in a job offer was assigned a value based on the connection to the competences in the syllabi of several subjects. The sum of all factors in the job offer by each syllabus indicated which syllabus

was more suitable. This method proved to be cumbersome and imprecise. Thus, it was intended to be automated with the use of AI.

3.7 Competence Extraction

The openAI library has been used to implement both the automatic extraction and the matching competences functionalities. To do this, an account was previously created at openai.com. With this account it was possible to generate an API key needed to work with the library. The working environment used was Google Colab, and the code was written in Python 3.5. The code for the competence extraction functionality is shown below.

```
!pip3 install -U openai
import openai

openai.api_key = 'sk- 45d3vK9sL8mN2cP6xQ7fG1hT0lO3pI2oU9yBnW4eR7kX1zA5' #My api-key

def get_completion(prompt, model = 'gpt-3.5-turbo'):
  messages = [{'role':'user', 'content':prompt}]
  response = openai.ChatCompletion.create(
      model = model,
      messages = messages,
      temperature = 0 #Do not generate random answers
  )
  return response.choices[0].message['content']

#Input of competences
text = """ Introduction to mathematical modeling of computational problems, as
           well as common algorithms, algorithmic paradigms, and data structures
           used to solve these problems. Emphasizes the relationship between algorithms
           and programming, and introduces basic performance measures and analysis
           techniques for these problems."""

#This is the prompt passed to the API
prompt = f""" Academic and professional competences are usually
              skills, knowledge or specific skills that have been
              acquired and developed through education, training
              or work experience.

              Statements describing personal interests, leisure
              activities and life experiences will not be considered as
              competences.

              Considering the above premises, your task is to extract
              competences in English from the following text:

             {text}
"""
```

```
response = get_completion(prompt)
print(text)
print(response)

Output:
Introduction to mathematical modeling of computational problems, as
           well as common algorithms, algorithmic paradigms, and data structures
           used to solve these problems. Emphasizes the relationship between algorithms
           and programming, and introduces basic performance measures and analysis
           techniques for these problems.
- Mathematical modeling of computational problems
- Knowledge of common algorithms
- Understanding of algorithmic paradigms
- Familiarity with data structures used to solve problems
- Ability to relate algorithms to programming
- Knowledge of basic performance measures and analysis techniques for computational problems
```

Figure 18: Automatic competence extraction with OpenAI

The previous code provides a detailed description of what a competence is, which is sufficient for detecting them in the input text. The text was extracted from the course description of 6.1210 Introduction to Algorithms (syllabus available at catalog.mit.edu/search/?P=6.1210), which is a subject in the Computer Science degree at the Massachusetts Institute of Technology. The result obtained is accurate and extracts competences appropriately.

3.8 Competence Matching

Obtaining the similarity index between sets of competences was based on two calculations, cosine similarity and Levenshtein distance. In the literature, there are more techniques that can be used to compare text strings, but the most well-known ones were selected. Specifically, cosine similarity uses the vector representation of the texts and measures the angle between them. The closer the vectors are, the higher the similarity. On the other hand, Levenshtein distance calculates the minimum number of operations (insertion, deletion, or substitution of characters) needed to convert one string into another. The smaller the distance, the higher the similarity. The code developed to obtain these two indices is given below. Figure 3 compares the texts in the previous figure and a new text taken from a job advertisement.

```
!pip3 install -U openai
import openai

openai.api_key = 'sk- 45d3vK9sL8mN2cP6xQ7fG1hT0lO3pI2oU9yBnW4eR7kX1zA5' #My api-key

def get_completion(prompt, model = 'gpt-3.5-turbo'):
  messages = [{'role':'user', 'content':prompt}]
  response = openai.ChatCompletion.create(
```

Funded by the Erasmus+ Programme of the European Union

```
      model = model,
      messages = messages,
      temperature = 0 #Do not generate random answers
  )
  return response.choices[0].message['content']

#Input of competences
text1 = """ Introduction to mathematical modeling of computational problems, as
            well as common algorithms, algorithmic paradigms, and data structures
            used to solve these problems. Emphasizes the relationship between algorithms
            and programming, and introduces basic performance measures and analysis techniques
            for these problems."""
text2 = """ Knowledge of patch management tools and techniques.
            Knowledge of the concepts and methodologies of information system analysis and
            development.
            Knowledge of operating systems such as Windows, Linux, and macOS.
            Knowledge of network protocols and security.
            Knowledge of scripting languages such as PowerShell, Python, and Bash.
            Ability to analyze and troubleshoot technical issues.
            Ability to work independently and as part of a team.
            Effective communication skills.
            Strong organizational skills.
            These are some of the skills that are required for a patch management job:
              Proactive, strategic, and detail-oriented approaches with a strong commitment to
                quality, efficiency, and effectiveness.
              Detail-oriented/attention to detail."""

#This is the prompt passed to the API
prompt = f"""Given the texts provided below:
             {text1}
             {text2}
             Calculate the similarity index between the two texts, taking into account
             the cosine similarity analysis. Calculate also the Levenshtein distance
             between both texts."""

response = get_completion(prompt)
print(response)
```

Output:

To calculate the cosine similarity index, texts must first be converted into term vectors. To do this, natural language processing techniques such as tokenisation and empty word removal can be used. The dot product between the vectors is then calculated and divided by the product of their magnitudes. The result is a value between 0 and 1 indicating the similarity between the texts, with 1 being perfect similarity.

```
The similarity index between the two texts is approximately 0.45, indicating that there is some
similarity between the topics covered in the two texts, but they are not identical.

The Levenshtein distance between the two texts is 292, indicating that there are a large number
of differences between the texts in terms of words and characters used.
```

Figure 19: Competence matching index with OpenAI

The cosine similarity indicates that both sets of competences are similar at 45%. Upon closer examination, it is evident that text 1 primarily consists of technical competences related to mathematics, computational problems, algorithms, data structures, and programming. In contrast, text 2 has 50% of its competences as technical, aligned with the same subject matter as text 1. Additionally, the remaining competences in text 2 are soft skills. Since text 1 lacks any soft skills, it is likely that the similarity between the two collections of competences is around 50%. Therefore, a 45% similarity is a valid result. On the other hand, the Levenshtein distance is 292, indicating that 292 operations must be performed for both texts to become similar.

3.9 Conclusions

In this work period, AI techniques have been explored to automate functionalities of the competence model. This would enhance user-friendliness and the potential adoption of the model. The results have been promising, as it is possible to propose new functionalities without requiring significant technical effort to implement them. In this work, two functionalities, competence extraction and matching, have been developed, but additional functionalities in which AI could play an important role could be developed. Some examples could be: searching for related competences based on keywords, suggesting competences to be incorporated into an academic course (reuse), intelligently making changes to the system's competences, proposing minimalist views of competences to provide comfort to users when reading them, using a chatbot to assist with any technical aspect of the model during its use...

Undoubtedly, AI is a powerful tool that should be used in conjunction with the competence model. During the development of the work, it was observed that providing precise textual descriptions was necessary when describing the task to be performed by AI. This was evident in the case of competence extraction, where it was found that through a brief but concise description, competences were correctly extracted from text. The option of directly downloading competences from URLs was explored. However, unexpected competences were obtained. HTML pages can contain diverse information, and AI may extract competences from sections that are not relevant. Due to this lack of control over the information that can be found in an HTML file, the decision was made to use textual descriptions instead of URLs as the source for extracting competences.

AI leverages advanced technologies and vast amounts of data. With all this information it is capable to provide personalized job recommendations, significantly reducing the time and effort required to find suitable

employment opportunities. However, as job search algorithms continue to evolve, it is crucial to address ethical considerations and ensure transparency and fairness in their implementation.

Some of these ethical considerations relate to the algorithmic bias that may be generated by the use of AI. It is important to ensure that matching algorithms are unbiased and do not discriminate against subjects on the basis of ethnicity, gender, age or other characteristics. Measures to identify and mitigate any algorithmic bias are therefore necessary. On the other hand, data privacy and security must be ensured during the job search, in compliance with applicable data protection regulations and standards. At all times, candidates must have control over how their data is used and give informed consent to its processing. Transparency and explainability is another factor to be taken into account in the automation of recruitment processes, as they must be transparent and understandable. Candidates and employers must be able to understand how selection decisions are made and what factors are taken into account. In addition, it is important to provide a clear explanation of how candidate data is used and how the matching process is carried out. AI must not widen existing inequalities in access to employment. It is essential to ensure equal access for all people, regardless of their background or circumstances, so that they have equal opportunities to access job vacancies and be considered in the selection process. Barriers or discrimination based on opaque criteria must be avoided. On the other hand, human assessment remains of vital importance, as although AI can be a useful tool in the competence matching process, it is important to maintain such an assessment, as the subjective and qualitative aspects of competences cannot always be captured by algorithms. Human intervention can provide an additional perspective and ensure that fair and equitable decisions are made.

It is important to extend the use of AI to match CVs with job vacancies and make it accessible to all users. By indicating completed studies, individuals can discover which job offers best match their profile. This not only makes the job search easier, but also increases efficiency by connecting candidates with the most relevant opportunities. By using AI responsibly and ethically, it is possible to create a labour market that is more inclusive, efficient and aligned with the needs and aspirations of both job seekers and employers. On the other hand, by taking into account the specific competences and requirements of each candidate, AI can help bridge the gap between job opportunities and candidate profiles, benefiting both individuals and businesses. To achieve this, it is essential to ensure transparency and fairness in the implementation of job search algorithms. Safeguards must be put in place to avoid bias and discrimination and to ensure that the selection process is fair and based on merit. It is also important to provide clear and understandable information about how the algorithms are used and how decisions are made, so that users can trust the system and understand how they have been assessed.

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LIST OF AUTHORS

1. José Alberto García Berná
2. Juan Manuel Carrillo de Gea
3. Begoña Moros
4. Joaquín Nicolás Ros

4 . A5.5. Development of the search engine mockup (UoI)

In today's digital age, online learning platforms have become a valuable resource for individuals seeking to expand their knowledge and skills. With a vast array of courses available on platforms like Moodle and Coursera, finding the right courses that align with one's interests and learning objectives can be a daunting task. To address this challenge, a search engine has been developed that enhances the user experience and simplifies the process of discovering relevant courses and competences.

This project leverages the power of algorithms and data-driven techniques to classify and organize the extensive course offerings available on Moodle and Coursera. By employing sophisticated algorithms, it is aimed to develop a search engine that enables users to efficiently locate courses that align with their specific interests and requirements. One such algorithm that plays a crucial role in this endeavor is the decision tree algorithm.

4.1 Algorithms

In the realm of computer science and information retrieval, algorithms play a pivotal role in solving complex problems and making informed decisions. An algorithm can be thought of as a step-by-step procedure or a set of rules that govern the execution of a specific task. In the context of the search engine project, algorithms are instrumental in processing vast amounts of course data and facilitating the efficient classification and retrieval of relevant courses.

One algorithm that holds significant promise for the search engine is the decision tree algorithm. Decision trees are powerful tools for classification and regression tasks, capable of handling both categorical and numerical data. These trees consist of nodes and branches that represent various decision points and possible outcomes.

At the core of the decision tree algorithm is the process of recursively partitioning the data based on different attributes or features. This partitioning is carried out in a way that maximizes the information gain or minimizes the impurity of the resulting subsets. By constructing a decision tree, we can create a hierarchical structure that enables efficient classification and prediction based on a series of decisions and criteria.

4.1.1 Application of Decision Trees in Course/Competence Classification

In the search engine, decision trees will serve as a vital component for organizing and classifying the vast array of courses available on Moodle and Coursera. By utilizing decision tree algorithms, we can automatically assign

courses, or even competences, to specific categories and subcategories based on their attributes, such as subject matter, difficulty level, skills or knowledge.

The decision tree algorithm will learn from a labeled dataset, where courses and competences are already assigned to appropriate categories. It will analyze the features and patterns within the dataset to create a tree structure that can accurately classify new, unseen courses. This will enable the search engine to suggest relevant courses to users based on their search queries, preferences, and prior interactions.

4.2 Database

A robust and well-structured database forms the backbone of the search engine. The database serves as a repository for storing and organizing the course and competence data, facilitating efficient retrieval and search functionalities.

4.2.1 Course Database

The course database consists of courses retrieved from Moodle and Coursera. It comprises tables that store the relevant information about each course. The tables are designed to capture key attributes such as the course title, description, subject area, instructor details, and learning outcomes.

To optimize the database performance, we employ appropriate indexing techniques on frequently accessed attributes such as course titles, subject areas, and instructor names. This enables faster search operations and enhances the overall user experience.

4.2.2 Competence Database

The integration of competences with job skills is a valuable aspect of the search engine. By combining the competence database with courses, a powerful tool is created for users to explore the connection between their educational journey and professional development.

Within the competence database, various information is stored to provide a comprehensive understanding of each competence. This includes details such as the competence name, description, related courses, and proficiency levels. These elements help users grasp the nature and scope of each competence.

The relationship between courses and competences is established within the database, enabling users to search for courses based on the specific competences they aim to acquire or improve. This functionality offers a targeted approach to learning, allowing individuals to align their educational pursuits with their desired skill set.

By incorporating competences into the search engine, the gap between academic and professional scenarios is bridged. Users can gain insights into how their learning outcomes translate into practical skills and abilities that are sought after in the job market. This integration empowers individuals to make informed decisions about their educational path, maximizing their potential for success in their chosen careers.

Overall, the combination of competences with job skills within the search engine offers users a holistic perspective on their learning journey. It facilitates the discovery of relevant courses, enhances skill development, and promotes alignment between academic achievements and professional aspirations.

4.3 Integration with Moodle and Coursera

The seamless integration of the search engine with Moodle and Coursera platforms plays a pivotal role in providing users with up-to-date and comprehensive course information. By connecting directly to these platforms, we can leverage their vast repositories of courses, ensuring that the search engine reflects the latest course offerings and updates.

4.3.1 API Integration

In addition to the integration with Moodle and Coursera, the system utilizes Application Programming Interfaces (APIs) provided by these platforms to facilitate seamless communication and data exchange. These APIs enable software systems to interact with one another, ensuring efficient access to relevant course information.

Authors are able to interact with the Moodle API for system integration, allowing for a smooth connection between the search engine and the Moodle platform. This integration ensures a seamless user experience while maintaining the search engine as an external tool separate from Moodle.

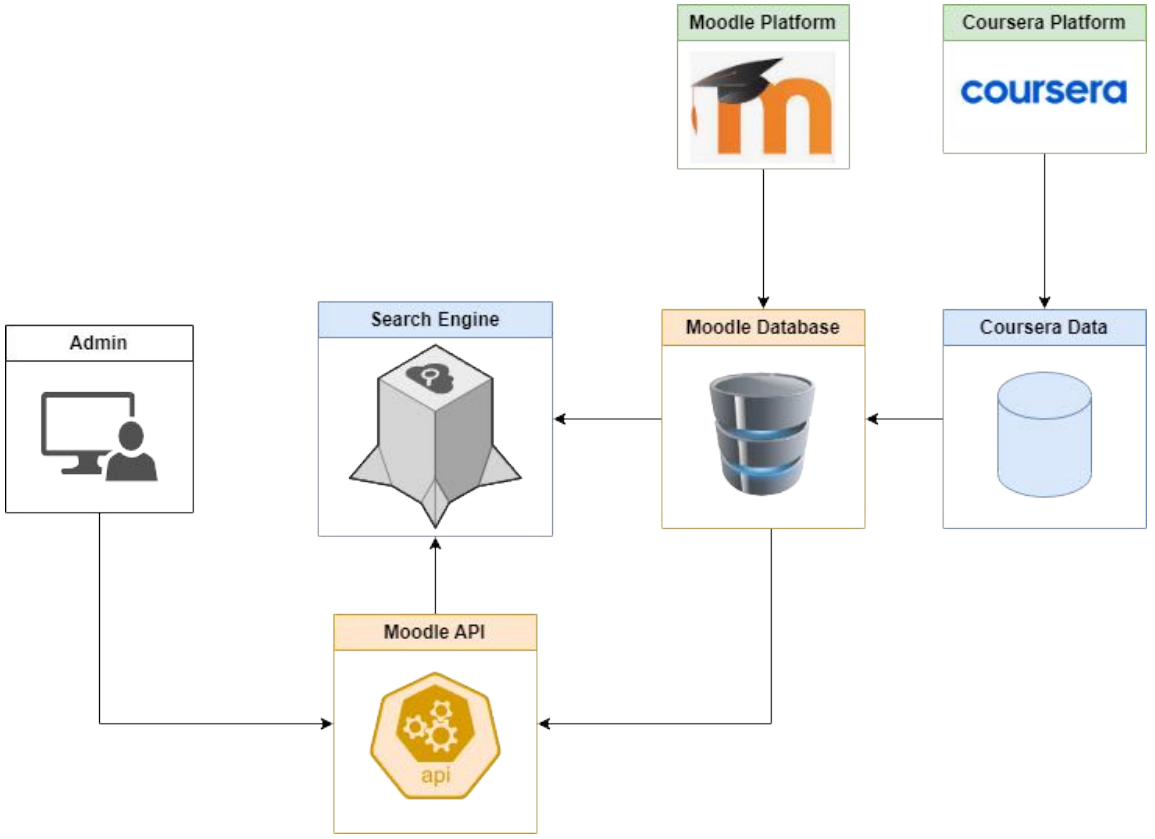

Figure 20. Integration Diagram

To enhance the integration further, the database is connected to the Moodle database. This connection enables the exchange of course information, ensuring that users can access comprehensive and up-to-date data through the search engine.

Furthermore, the integration with Coursera involves importing data into the Moodle database. This process expands the range of available courses by incorporating information from the Coursera platform. Importing data from Coursera enriches the search engine's offerings, providing users with a diverse selection of courses from both Moodle and Coursera platforms.

The search engine integrates with Moodle and Coursera platforms through the use of their respective APIs. The Moodle API facilitates system integration, allowing seamless communication between the search engine and Moodle. Additionally, the search engine connects to the Moodle database to exchange course information, ensuring access to up-to-date data.

Furthermore, the search engine imports data from Coursera into the Moodle database, expanding the available courses. This integration with Coursera enhances the search engine's offerings, providing users with a diverse selection of courses from both platforms.

Overall, the utilization of APIs, interaction with the Moodle API, connection with the Moodle database, and import of data from Coursera contribute to a robust search engine that seamlessly integrates with Moodle and Coursera, enhancing the learning experience for users.

4.3.2 Data Synchronization

One of the key aspects of the integration is data synchronization between the search engine and Moodle/Coursera platforms. Course data are periodically retrieved from these platforms to ensure that the database is up to date with the latest course offerings, modifications, and deletions. This synchronization process helps to provide users with accurate and current course information, enhancing the relevance and usefulness of the search engine.

4.3.3 Data Retrieval and Parsing

Using the APIs, the search engine interacts with Moodle and Coursera to retrieve the necessary course data. The APIs provide endpoints and methods to query the platforms' databases and retrieve information such as course titles, descriptions, subject areas, and instructor details. Once the data is retrieved, it is parsed and transformed into a format compatible with the search engine's database and classification algorithms.

4.4 Architecture

The architecture of the search engine comprises various components that work together to deliver an efficient and user-friendly course and competence discovery experience. This architecture encompasses data management, algorithmic processing, user interface, and system integration.

4.4.1 Components of the Architecture

- **User Interface (UI):** The user interface component provides the interface through which users interact with the search engine. It includes the design elements, user input forms, search functionalities, and result visualization. The UI is designed to be intuitive, and visually appealing, enabling users to easily search for courses, explore competences, and receive relevant recommendations.
- **Database Management System (DBMS):** The DBMS component is responsible for managing the course and competence data within the database. It handles data storage, retrieval, and ensures data integrity and consistency. The DBMS interacts with the other components to provide seamless access to relevant course and competence information.
- **Algorithmic Processing:** The algorithmic processing component incorporates the decision tree algorithm, among others, to classify courses and associate them with relevant competences. It analyzes the course attributes and uses the decision tree model to predict the appropriate category or subcategory for each course. This component ensures that courses are accurately organized, making it easier for users to discover relevant content.
- **Search Engine Core:** The search engine core component acts as the central processing unit, integrating the user interface, database, and algorithmic processing. It receives user search queries, interacts with the database to retrieve relevant course and competence information, and applies the classification algorithms to provide accurate search results. The search engine core optimizes search performance, ensuring quick and efficient responses to user queries.
- **Integration with Moodle and Coursera:** The search engine integrates with Moodle and Coursera, leveraging the APIs (Application Programming Interfaces) provided by these platforms. This integration allows the search engine to access and retrieve course data directly from Moodle and Coursera, ensuring the latest and most up-to-date information is available to users. This integration also enables synchronization between the search engine and the course offerings on these platforms.

4.4.2 Communication and Flow

The components within the architecture communicate and interact with each other to deliver a seamless user experience. The user interface component receives user input and communicates search queries to the search engine core. The search engine core interacts with the DBMS to retrieve course and competence information, and it further processes the data using the algorithmic processing component. The results are then passed back to the user interface for display to the user.

4.4.3 Architecture Diagram

According to the architecture described above and its components, the following diagram is obtained:

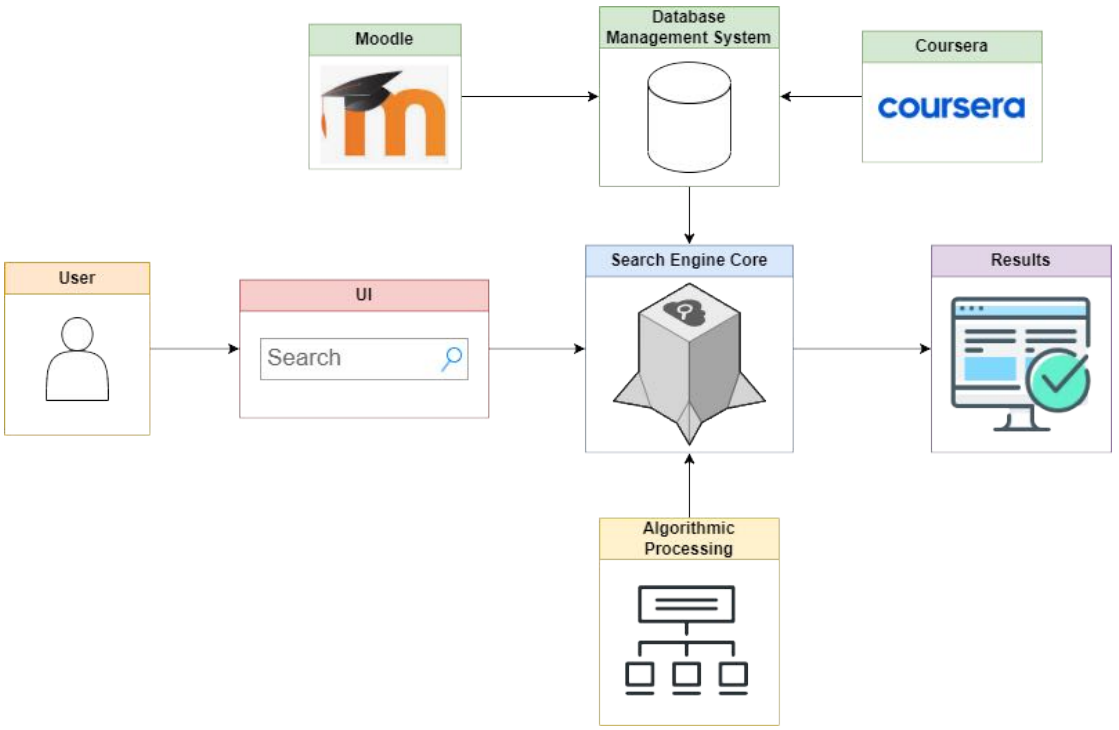

Figure 21. Architecture Diagram of the Search Engine

4.5 Users

The search engine caters to a diverse range of users, each with unique preferences, goals, and requirements. Understanding the user profiles is essential for designing a user-centric search experience. The following are some of the key user profiles identified:

- **General Public:** These are anonymous users who visit the search engine without creating an account. They have access to basic functionalities and can explore a subset of the course and competence information available. They might be interested in discovering courses or gaining an overview of the platform's offerings.
- **Students and Learners:** This user profile comprises individuals seeking educational opportunities, including students, self-learners, or professionals looking to upskill. They utilize the search engine to find relevant courses and competences that align with their interests, educational needs, or career aspirations.
- **Educators and Instructors:** This profile includes teachers, professors, and instructors who are searching for courses to enhance their teaching curriculum or professional development. They seek courses that cover specific subjects or competences, enabling them to broaden their knowledge and deliver high-quality education.

- **Employers and Recruiters:** This user profile consists of employers, recruiters, and HR professionals who utilize the search engine to identify courses and competences that align with their organization's skill requirements. They may seek courses that can enhance the skills and qualifications of their workforce or aid in talent acquisition.

4.5.1 Authentication and Authorization

According to the roles described above, the following authentication and authorization rights arise:

General Public

Authentication: The search engine allows anonymous access without requiring user authentication. General public users can browse and explore a subset of course and competence information without creating an account.

Authorization and Rights: Since they are anonymous users, their access is limited to basic functionalities. They can view course overviews, explore platform offerings, and access general information. However, they do not have access to advanced features or personalized content.

Students and Learners

Authentication: Students and learners are required to create an account to access the full functionality of the search engine. They need to authenticate themselves using a username and password or other authentication methods.

Authorization and Rights: Authenticated students and learners have expanded access and rights within the search engine. They can search for relevant courses and competences, enroll in courses and track their progress. They may also have the ability to save courses, leave reviews, and participate in discussion forums.

Educators and Instructors

Authentication: Educators and instructors need to create an account and authenticate themselves using a username and password or other authentication methods to access specific features tailored to their needs.

Authorization and Rights: Authenticated educators and instructors have additional rights and access compared to general users. They can search for courses and competences relevant to their teaching curriculum or professional development goals. They may have access to additional features, such as the ability to create and manage course content, access teaching resources, participate in online teaching communities, and provide feedback on courses.

Employers and Recruiters

Authentication: Employers and recruiters are required to create an account and authenticate themselves to access the search engine's features catering to their specific needs.

Authorization and Rights: Authenticated employers and recruiters have specialized rights and access within the search engine. They can search for courses and competences that align with their organization's skill requirements. They may have access to features like talent acquisition tools, the ability to track employee progress, access employer-specific resources, and collaborate with educational institutions. They may also have the ability to recommend courses to their employees or use the search engine as a tool for professional development within their organization.

4.5.2 User Experience (UX)

The search engine aims to provide an intuitive and user-friendly experience for all user profiles. The user interface is designed with a focus on simplicity, ease of use, and efficient information retrieval. Key considerations for the user experience include:

- Clear and intuitive search functionalities to enable users to find courses and competences based on their specific criteria.

- Well-organized course and competence information, including titles, descriptions, instructors, ratings, and prerequisites, to aid users in making informed decisions.

- Personalization features that allow users to save their preferences, bookmark courses, receive recommendations, and track their learning progress.

- Responsive design to ensure a seamless experience across different devices and screen sizes, enabling users to access the search engine anytime, anywhere.

4.5.3 Feedback and Continuous Improvement

User feedback plays a crucial role in the enhancement of the search engine's usability and effectiveness. The project incorporates mechanisms to gather feedback from users, such as surveys, user testing, and analytics. The collected feedback is carefully analyzed to identify areas of improvement and to iteratively enhance the search engine's features and functionalities.

4.5.4 Privacy and Data Protection

Respecting user privacy and ensuring the security of user data are paramount considerations. The search engine adheres to data protection regulations and implements measures to safeguard user information. This includes secure data storage, encrypted communication, and compliance with privacy policies.

By considering the diverse user profiles, focusing on user experience, collecting and incorporating user feedback, and prioritizing privacy and data protection, the search engine aims to create a valuable and user-centric platform for users seeking courses and competences.

4.6 Search Engine Mockup

Based on the previous analysis and information, below follows a compact mockup of a competence-based search engine designed to enhance the user's learning experience. The mockup showcases a user-friendly interface with a prominent search bar, allowing users to enter courses, competences, or specific skills they want to develop. In addition, the search engine's key features include the ability to search for courses based on specific competences, ensuring a targeted learning approach.

The search engine seamlessly integrates with Moodle and Coursera platforms, leveraging their Application Programming Interfaces (APIs) for efficient data retrieval. By connecting to the Moodle and Coursera databases, the search engine provides access to a diverse range of courses from both platforms. The mockup also incorporates a competence database, capturing essential skills, knowledge, and abilities associated with each course. Users can explore competences, view details, and understand how their educational journey aligns with professional scenarios.

According to each role and user profile, the search engine will provide different or modified content. Above follow some mockups that depict the possible and targeted outcome of the search engine.

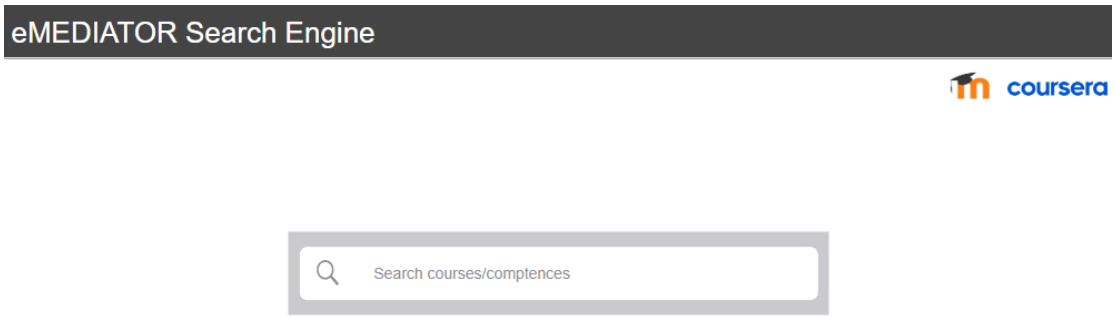

Figure 22. Search Engine Mockup – General Public

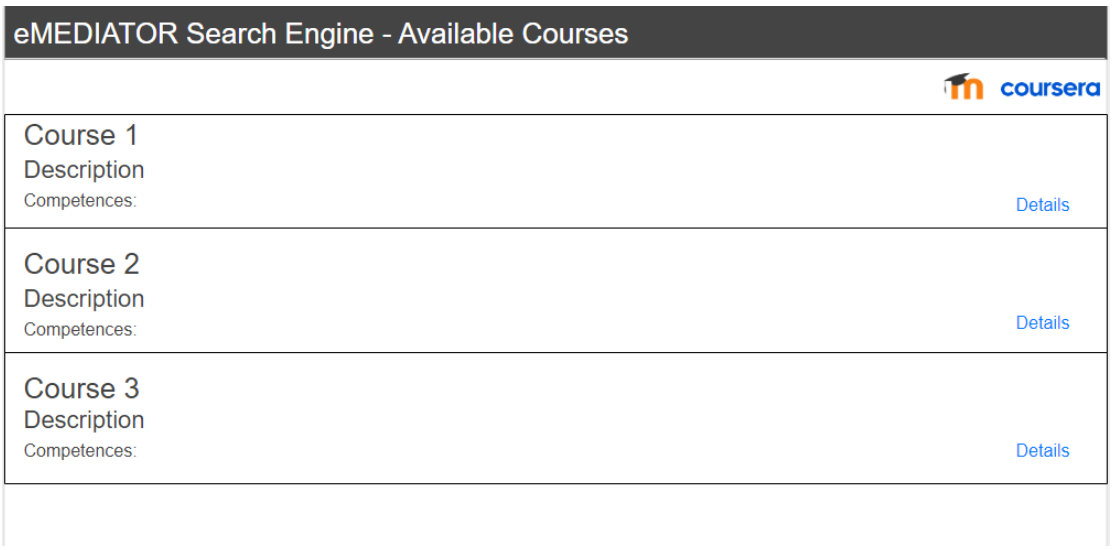

Figure 23. Search Engine Mockup – Results for General Public

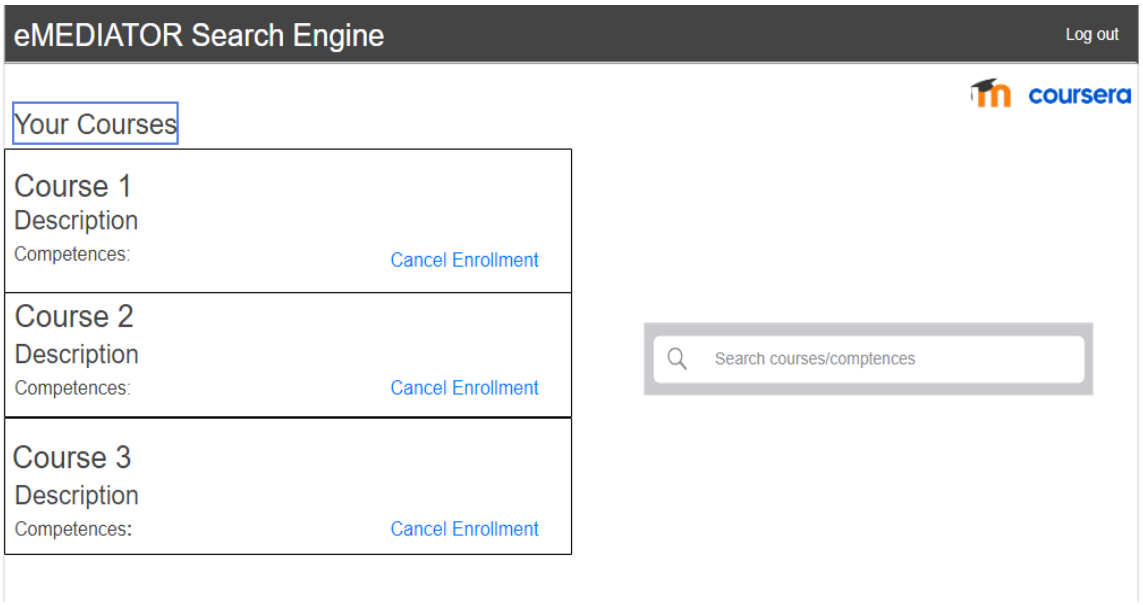

Figure 24. Search Engine Mockup – Students and Learners

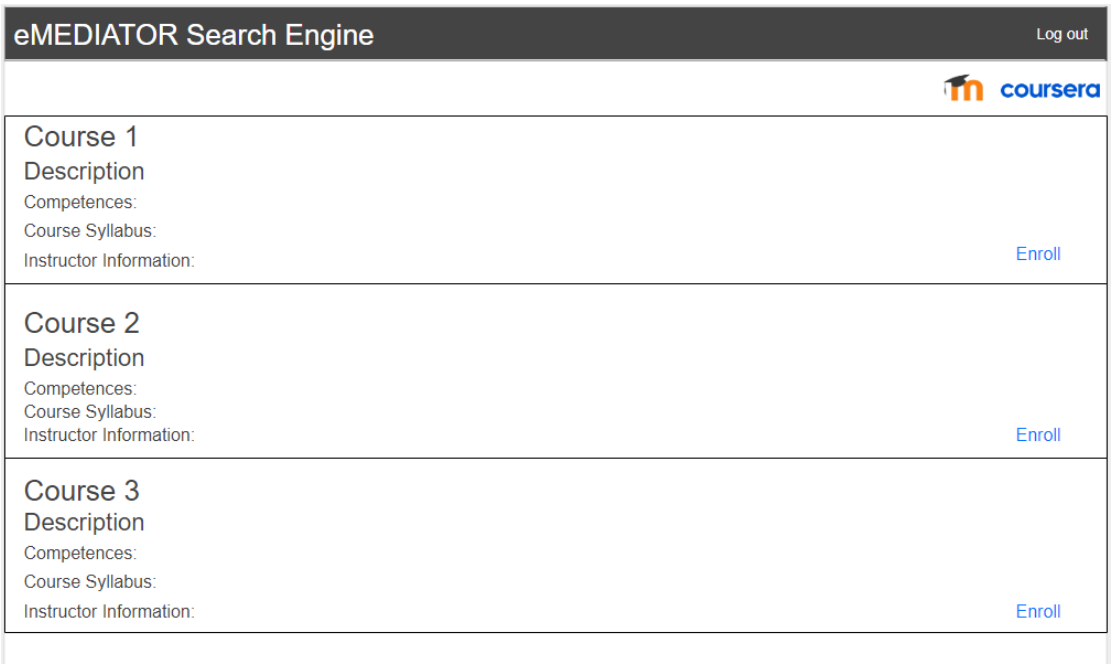

Figure 25. Search Engine Mockup – Results for Students and Learners

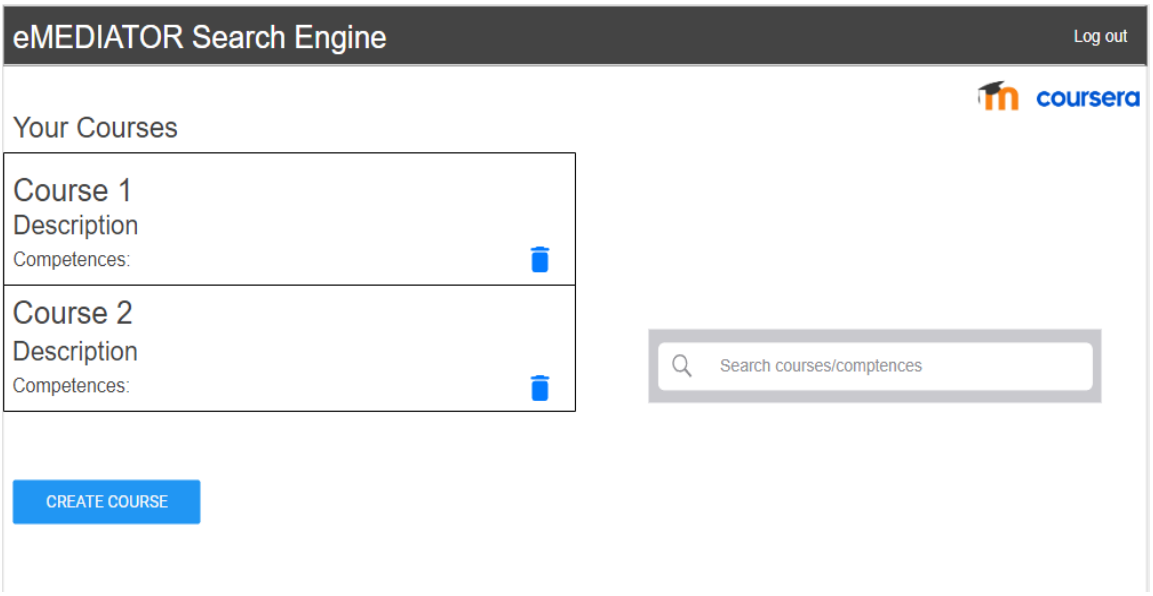

Figure 26. Search Engine Mockup – Educators and Instructors

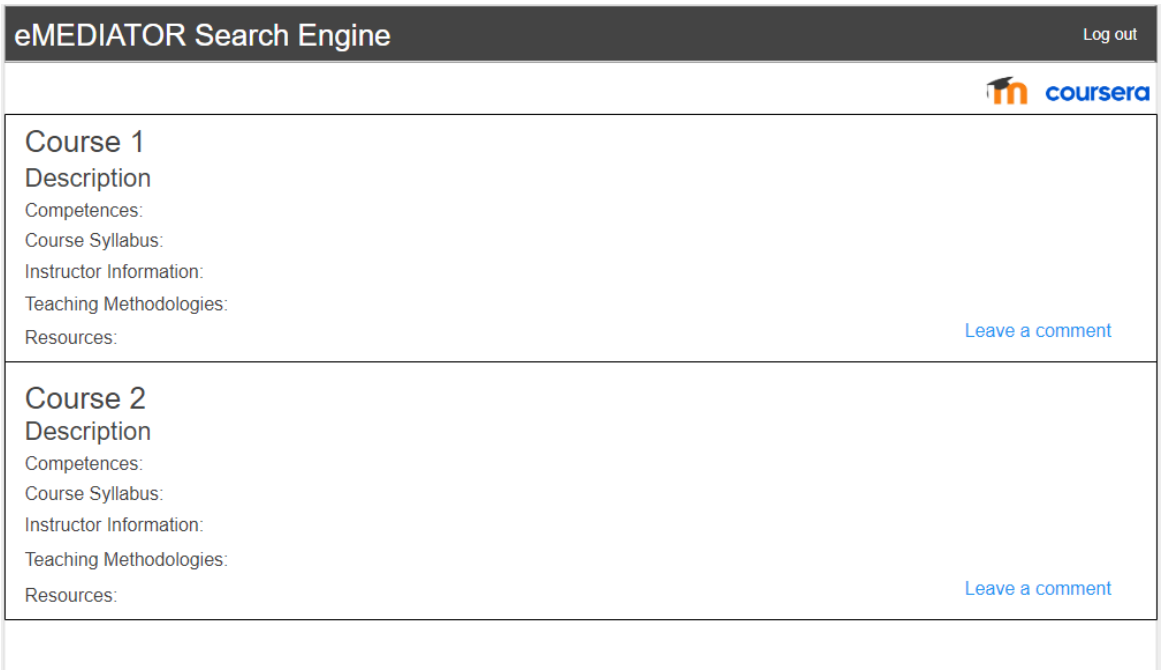

Figure 27. Search Engine Mockup – Resutls for Educators and Instructors

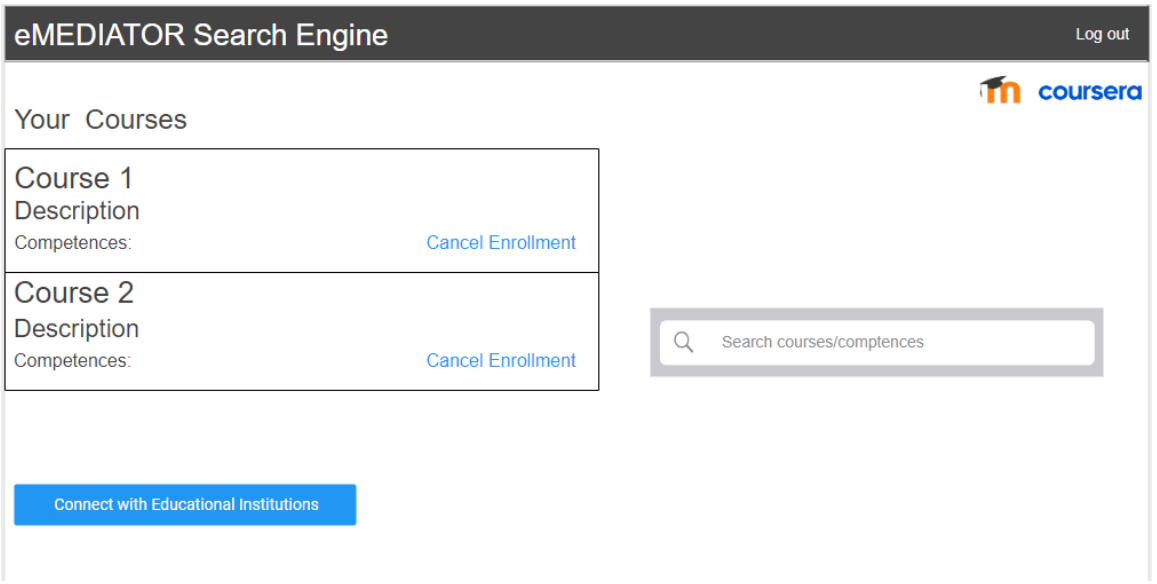

Figure 28. Search Engine Mockup – Employers and Recruiters

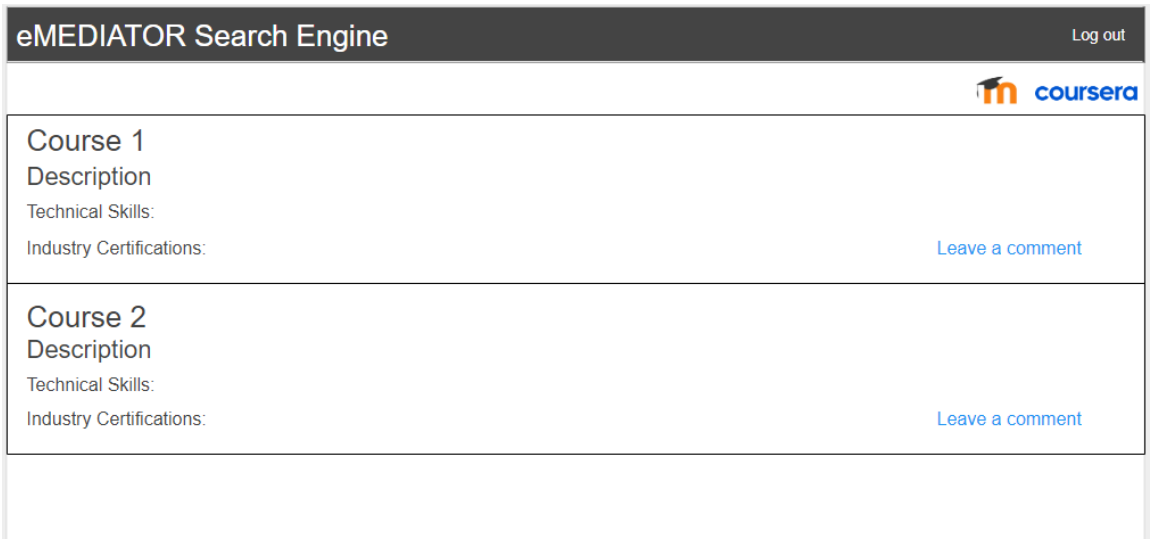

Figure 29. Search Engine Mockup – Results for Employers and Recruiters

Overall, these mockups demonstrate the search engine's capability to integrate with Moodle and Coursera, provide competence-based searching, and enhance the user's learning outcomes.

LIST OF AUTHORS

1. Vasia Liagkou
2. Katerina Florou

5 . A6.5 Pilot testing of the demo version of the portal (AU)

This section describes the report of the executed activities by the team of Aalen University.

5.1 Pilot testing report

Introduction

The purpose of this test report is to assess the suitability of Liferay as a platform for the eMEDIATOR system. eMEDIATOR aims to provide a connection platform between science, business, and students, facilitating collaboration and knowledge exchange. As the Chief Tester, I have conducted extensive testing to evaluate the system's performance, capabilities, and potential issues.

1. Liferay as the Right Tool for the Productive Version

After rigorous testing of the eMEDIATOR system on the Liferay platform, it is evident that Liferay is a robust and suitable tool for the productive version. The platform provides a comprehensive set of features and functionalities, including user management, content management, document sharing, and social collaboration tools. Liferay's versatility and scalability ensure that the eMEDIATOR system can grow and adapt to the needs of its users.

During testing, Liferay demonstrated excellent performance in handling large datasets and concurrent user interactions. The system maintained stability and responsiveness even under heavy loads, which is crucial for a productive version that caters to multiple stakeholders simultaneously.

2. Suitability of Liferay for the Prototype

While Liferay proves to be an excellent choice for the productive version, it might not be the most suitable option for the prototype. One key factor is its extensive array of features, which can be overwhelming for a prototype that requires rapid development and iteration.

Liferay's richness might lead to longer development cycles, hindering the quick delivery of a minimum viable product. In contrast, a simpler platform could allow for faster prototyping and a more agile development process.

3. Aalen University's Suggestion to Switch to WordPress for Faster Demo Application Development

Based on Aalen University's suggestion, switching to WordPress for the prototype and demo application development appears to be a valid consideration. WordPress offers a user-friendly interface and a wide range of pre-designed templates that can expedite the development process.

With WordPress, developers can quickly set up and customize the platform to showcase the core functionalities of eMEDIATOR. It allows for efficient content management and ease of use, essential aspects when showcasing the system's capabilities during demos and presentations.

However, it's essential to consider that while WordPress might be suitable for rapid prototyping, its scalability and ability to handle complex features could be limited compared to Liferay for the productive version.

4. Setup on a Linux-Based Server

During the testing process, it was observed that the eMEDIATOR system performs optimally when deployed on a Linux-based server. Linux offers a stable and secure environment, which is crucial for hosting a platform that involves sensitive scientific, business, and student-related data.

Additionally, the Linux ecosystem provides a wide range of tools and resources for server management and optimization, enabling better control over system performance and resource utilization.

5. Design of the Platform

One aspect that surfaced during testing is the design of the eMEDIATOR platform. While Liferay allows for extensive customization, achieving the desired design might require considerable effort. The current design may not fully align with the project's branding and user experience goals.

WordPress, on the other hand, offers a selection of easy-to-use and visually appealing templates, providing a quick and visually pleasing out-of-the-box solution. This advantage can be significant during the initial stages when design and user experience feedback are crucial for further development.

Conclusion

In conclusion, Liferay is undeniably the right choice for the productive version of the eMEDIATOR system. Its powerful features, scalability, and stability make it an ideal platform for supporting the needs of science, business, and students effectively.

However, for the prototype and demo application development, the use of WordPress could be considered, as it offers faster development with its user-friendly templates and ease of customization. The decision to use WordPress for prototyping should be based on the project's goals, timeline, and resource constraints.

Lastly, it is recommended to deploy the eMEDIATOR system on a Linux-based server to ensure optimal performance, security, and resource management.

The design aspect requires further attention, whether through customizing Liferay's interface or using WordPress templates that align with the project's branding and user experience objectives.

Overall, a combination of Liferay and WordPress, based on the project's development stage, can lead to a successful eMEDIATOR system that effectively bridges the gap between science, business, and students.

5.2 Current stage of development

The following image shows the timescale of the ongoing project activities:

Project Code 2021-1-LV01-KA220-HED-000027571 ERASMUS+ Project eMEDIATOR
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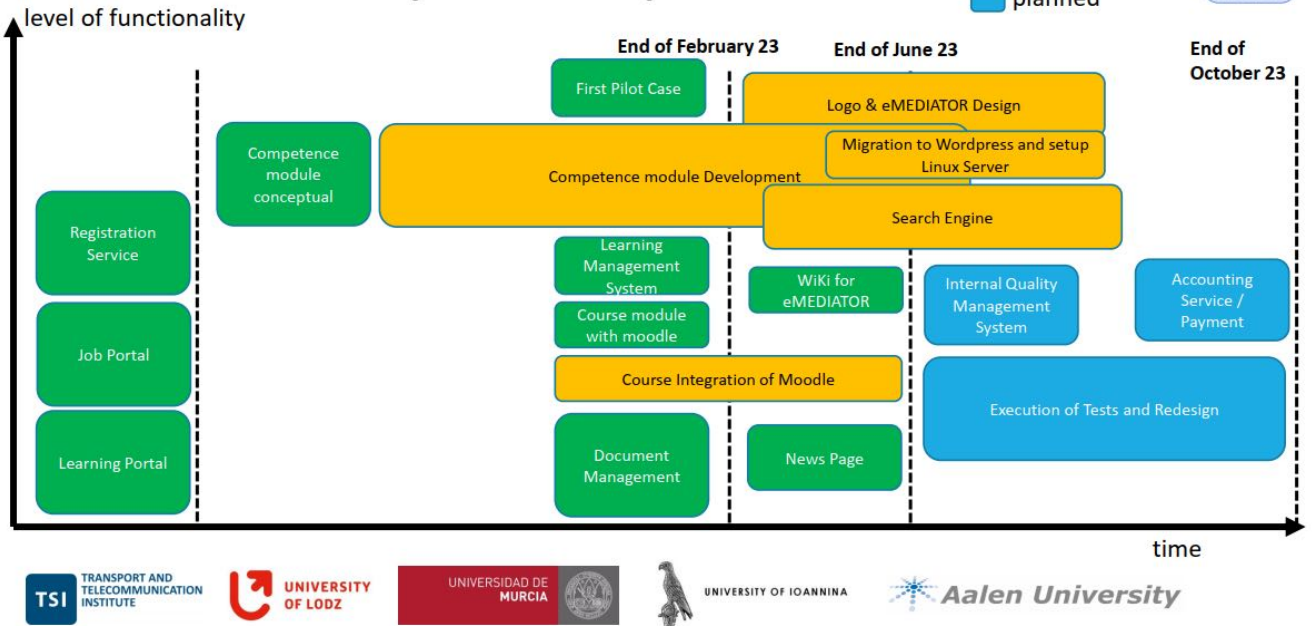

Completed Work Packages

1. Migration to WordPress and Setup of Linux Server:

A major milestone has been achieved with the successful migration of the eMEDIATOR system to WordPress and the setup of the Linux server. The decision to migrate to WordPress was made based on Aalen University's suggestion for faster demo application development. This integration provides a user-friendly interface and access to a range of pre-designed templates, facilitating further development. Additionally, the deployment of the platform on a Linux-based server ensures stability and security for hosting sensitive scientific, business, and student-related data.

2. Moodle Integration:

Another significant accomplishment is the seamless integration of Moodle, a widely-used Learning Management System (LMS). This integration enhances the platform's capabilities, allowing students to access course materials and participate in interactive learning experiences directly through eMEDIATOR. The successful Moodle integration demonstrates the team's ability to work with diverse technologies and leverage existing systems to improve the overall user experience.

Ongoing Work Packages

Competence Module Development:

The team is actively engaged in developing the Competence Module, a pivotal component of the eMEDIATOR system. This module aims to enable students to easily select competences from available courses they wish to learn. The development of this module requires careful consideration of user needs, intuitive design, and efficient implementation. As the Project Manager, close monitoring of this work package is essential to ensure its timely completion and alignment with the project's objectives.

Integration of Search Engine Functionality with AI:

The integration of a search engine functionality based on similarity search for competences using Artificial Intelligence (AI) is an exciting and challenging endeavor. This functionality aims to enhance the user experience by providing relevant and personalized course recommendations based on individual competences. The team has made notable progress in implementing AI algorithms to analyze and match competences. However, given the complexity of AI integration, close collaboration with AI experts and continuous testing will be necessary to ensure the search engine's accuracy and efficiency.

5.3 Migration report of the successful migration of eMEDIATOR from Liferay to Wordpress

1. Introduction

This migration report outlines the successful migration of the eMEDIATOR portal demo from the Liferay platform to WordPress. The decision to migrate to WordPress was based on the need for faster demo application development and the desire to leverage WordPress's user-friendly interface and out-of-the-box design templates. The migration process involved careful planning, thorough testing, and collaboration between development teams to ensure a seamless transition while preserving the core functionalities and user experience of the eMEDIATOR portal.

2. Migration Process

The migration process was divided into several key stages to ensure a systematic and efficient transition from Liferay to WordPress:

a. Planning and Pre-migration Preparation:

In this initial stage, the project team thoroughly assessed the current state of the eMEDIATOR portal on Liferay. This included identifying the key functionalities, content structure, and customizations present in the existing platform. The team also performed a comprehensive analysis of the WordPress platform and its capabilities to determine the feasibility of migration.

b. Data and Content Migration:

The next step involved transferring the data and content from the Liferay portal to WordPress. This process required careful consideration, as the data structures and content formats in Liferay and WordPress differ. The team developed custom scripts and plugins to migrate user data, courses, documents, and other content seamlessly. Manual content migration was also performed to ensure accuracy and data integrity.

c. Theme and Design Customization:

As the eMEDIATOR portal demo is a representation of the final product, ensuring a consistent and visually appealing design was crucial. The team customized a WordPress theme to align with the project's branding and design requirements. This involved creating a user-friendly layout, optimizing responsiveness, and integrating the eMEDIATOR logo and color scheme.

d. Functionality Replication:

To maintain the core functionalities of the eMEDIATOR portal, the team worked on replicating the essential features available in Liferay. WordPress plugins were utilized to provide similar functionalities, including user management, course selection, and search engine integration. The AI-based similarity search for competences, a critical feature of the portal, was successfully implemented using custom-developed plugins.

e. Quality Assurance and Testing:

Throughout the migration process, rigorous testing was conducted to identify and rectify any issues or discrepancies. Both automated and manual testing procedures were employed to ensure that the migrated portal worked seamlessly on the WordPress platform. The team also conducted user testing to gather feedback and ensure a positive user experience.

3. Key Achievements and Benefits

The migration of the eMEDIATOR portal demo from Liferay to WordPress yielded several key achievements and benefits:

a. Faster Demo Application Development:

The adoption of WordPress significantly accelerated the development process for the portal demo. WordPress's user-friendly interface and pre-designed templates allowed the team to focus on customizing the platform to meet the project's specific requirements quickly.

b. Improved Design and User Experience:

The WordPress migration enabled the implementation of visually appealing designs and a user-friendly layout. The new theme customization ensured a consistent and attractive user interface, enhancing the overall user experience.

c. Seamless Integration of AI-based Search:

The successful integration of AI-based similarity search for competences demonstrated the flexibility of WordPress and the team's ability to develop custom plugins. This functionality, a core feature of the eMEDIATOR portal, remained intact throughout the migration. It is still in development, testing and optimization.

d. Enhanced Platform Scalability:

WordPress's scalability and vast plugin ecosystem offer the potential for easy expansion and future enhancements to the eMEDIATOR portal demo. This allows the platform to adapt to the evolving needs of science, business, and students effectively.

4. Conclusion

The migration of the eMEDIATOR portal demo from Liferay to WordPress marks a significant achievement for the project. The successful transition ensures a faster and more efficient demo application development process, while also providing improved design, user experience, and AI-based search functionality. The project team's meticulous planning, seamless data migration, and thorough testing were instrumental in the successful completion of the migration process.

With the WordPress version of the eMEDIATOR portal demo now available via http://emediator.org, stakeholders can experience the platform's enhanced features and capabilities. As the project progresses, the team will continue to gather user feedback and further optimize the platform, ensuring that eMEDIATOR remains a cutting-edge connection platform between science, business, and students.

The following screenshots from the mobile version show the good user interface and give an impression of the look and feel of the portal:

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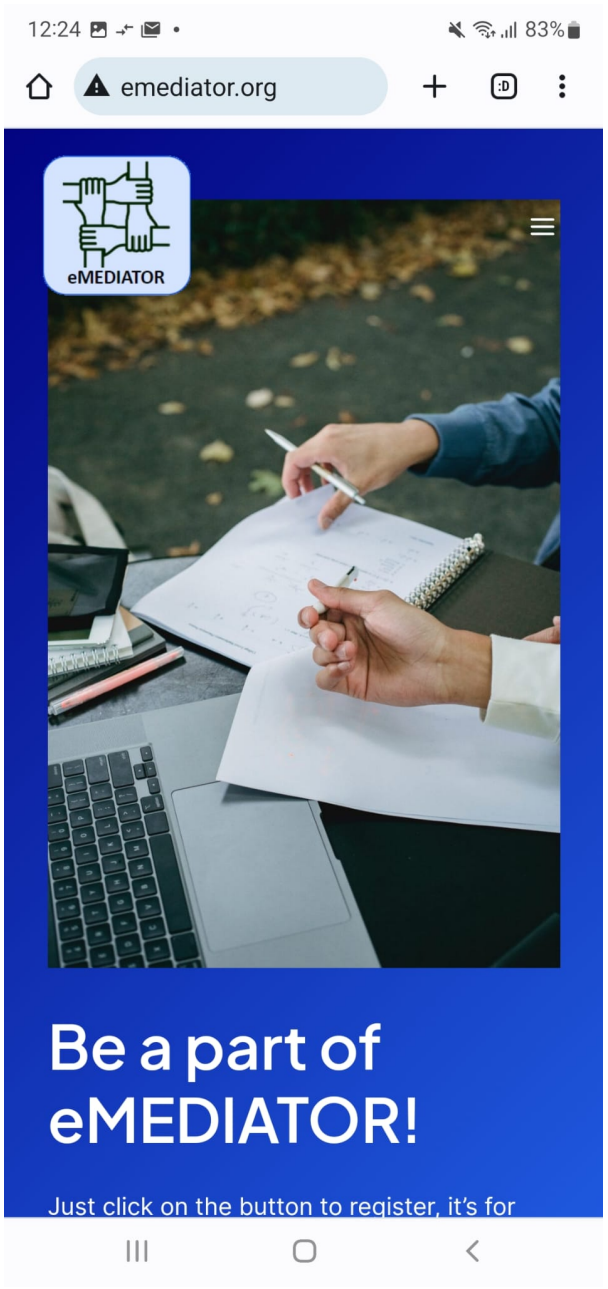

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UNIVERSITY OF LODZ
UNIVERSIDAD DE MURCIA
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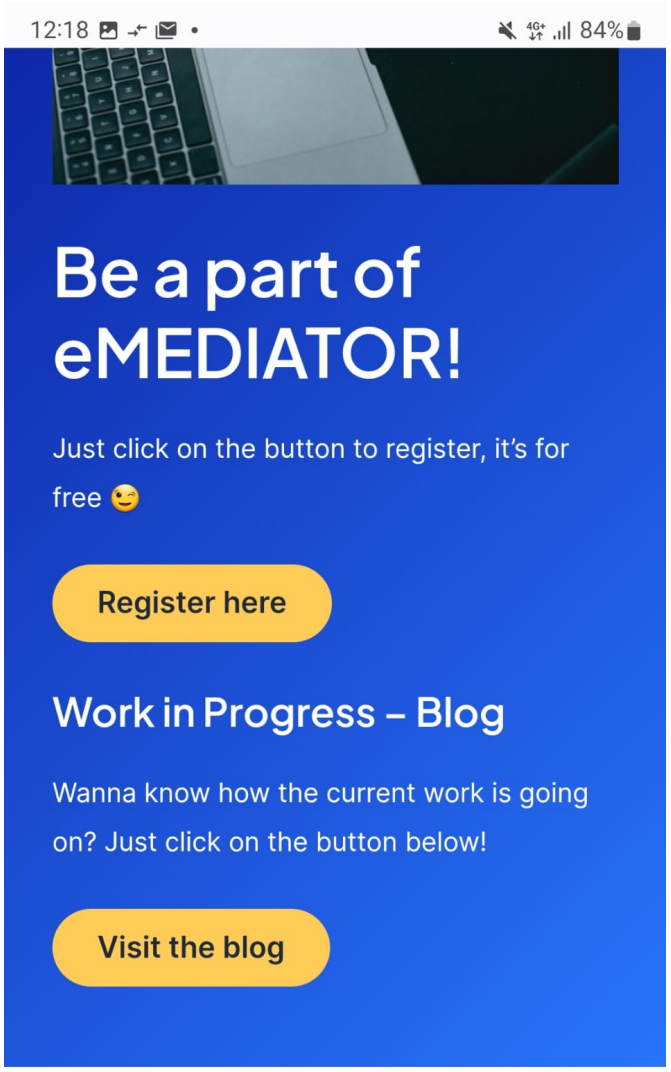

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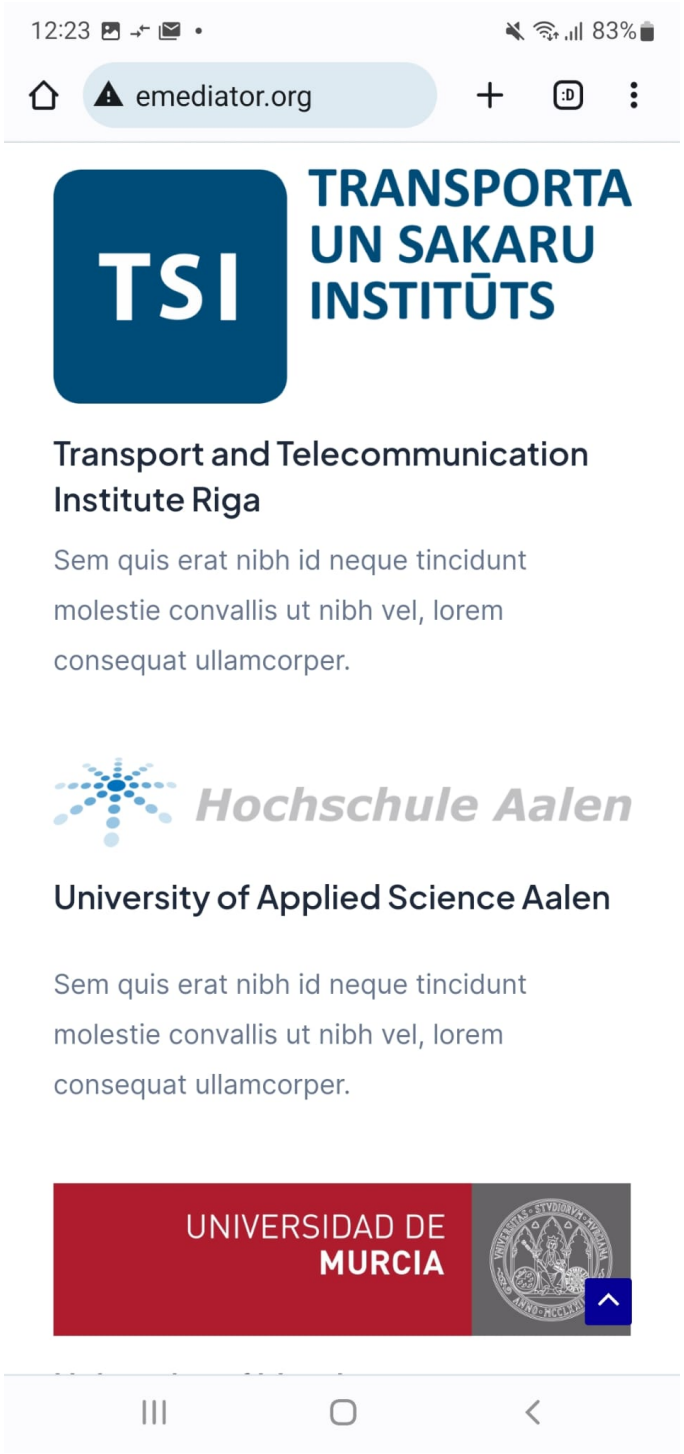

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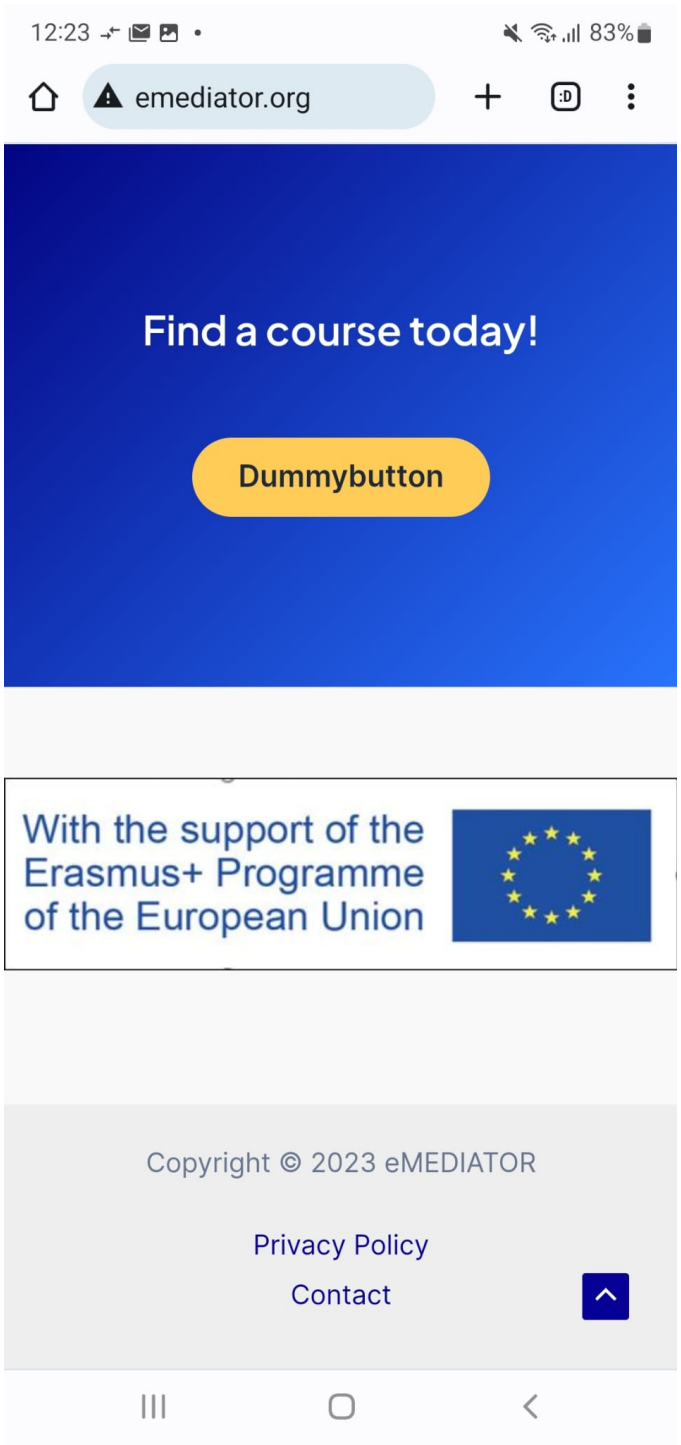

LIST OF AUTHORS

1. Nicolas Dolle

2. Christian Wilhelm

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