



Bilkent University
Department of Computer Engineering

Senior Design Project – CS 491

T2416

Edux

Project Specification Document

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1. Introduction

In today's fast-paced world, learning and staying ahead requires more than just access to resources. It demands efficiency, adaptability, and focus. While the internet and digital platforms have made educational content more accessible than ever, they've also created an ocean of information that often overwhelms learners. Juggling multiple resources, managing time, and ensuring progress can be intimidating, many find it hard to keep knowledge and reach their goals.

This is where Edux steps in as a game-changer. Edux changes the learning process by utilizing the power of large language models (LLMs) and personalized tools to make learning more effective and interactive. With features like detailed explanations powered by LLMs, customizable study aids, and dynamic progress tracking, Edux transforms scattered study efforts into structured, goal-oriented journeys. By tailoring study schedules to individual needs and generating interactive tools such as flashcards, quizzes, and skill trees from user-uploaded content, Edux simplifies complex learning processes while boosting understanding and retention. Moreover, Edux also bridges the gap between students and instructors, offering collaborative tools like task assignments and automated evaluations that ensure academic integrity and consistency between theoretical and practical work. With plans for future expansion into mobile and tablets, Edux is poised to meet the evolving demands of modern education, though these developments fall outside the current scope of the senior design project.

This report provides a comprehensive overview of Edux, including its core components, high-level system architecture, constraints, professional and ethical issues and standards. Additionally, the design requirements -the functional and non-functional requirements-, market analysis and academic analysis are detailed to demonstrate how Edux sets a new standard for interactive and personalized learning.

1.1. Description

Edux is a web application designed to improve how people learn and assess knowledge. It supports learners by providing tools and features that enhance understanding, retention, and organization.

Edux allows learners to upload various study resources, including scholarly articles, textbooks, slides, syllabi, and other materials. Using LLMs, Edux provides detailed explanations of these resources, either page-by-page or in the context of the entire content. Supported formats include images, reports, slides, and books, with plans to integrate voice recordings in the future.

Edux includes interactive learning tools like flashcards, skill trees and quizzes to reinforce knowledge and assess progress. Flashcards and quizzes are created based on the user's

uploaded content to their individual study. Skill trees can be predefined individual studies with hierarchical structures or custom skill trees created by learners based on the content uploaded to their individual studies.

To help learners manage their time effectively, Edux generates personalized study schedules. These schedules are customized based on a user's syllabus, can be manually entered or uploaded, and include performance in assessment tools and time spent on these assessments. They promote efficient planning by identifying areas that require improvement and helping learners focus their efforts where it matters most.

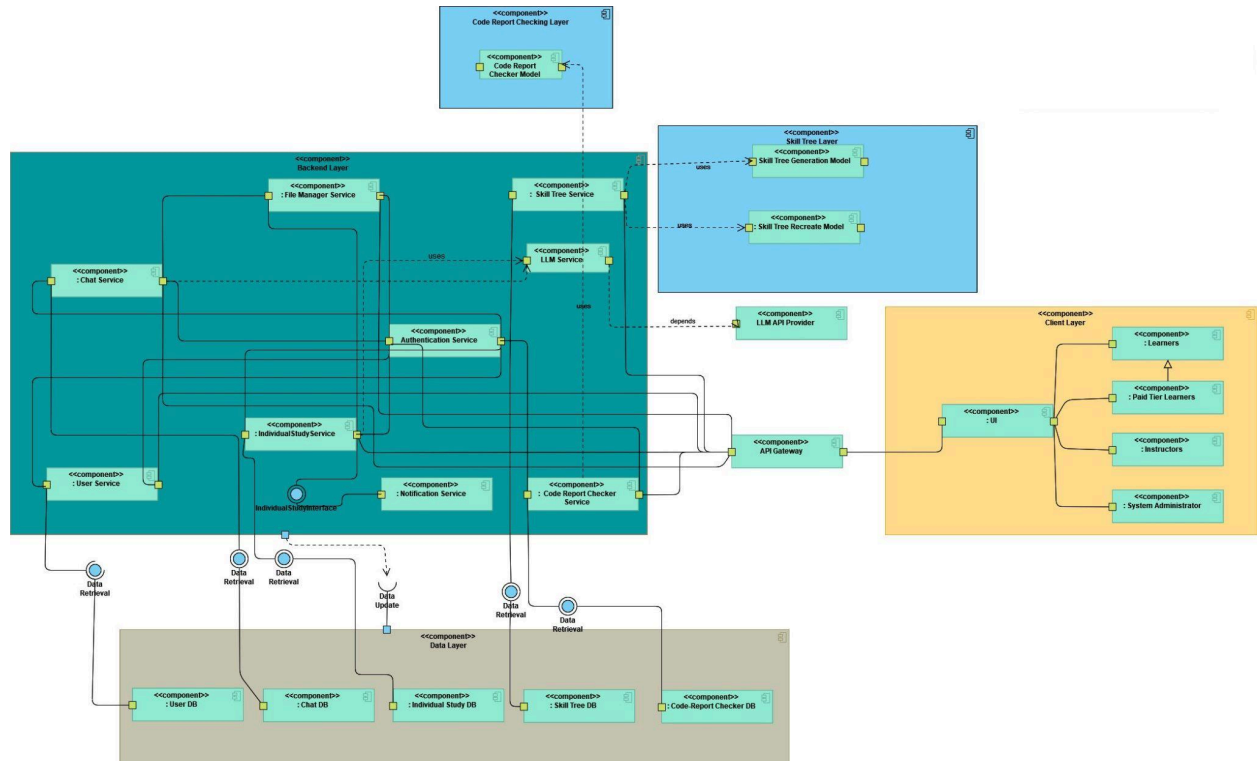
The platform also will offer user-instructor relationships for engineering students. Instructors can assign tasks that will include reports and coding projects to students in their classes. Edux will include a model that will evaluate whether the submitted report aligns with the assigned code, ensuring consistency between theory and practices and will promote academic integrity.

Edux is designed with plans to introduce paid tiers in the future, offering advanced features to enhance the learning experience. One such feature will be Retrieval-Augmented Generation (RAG), which will enable users to create content such as practice questions similar to publicly available past exams while ensuring the questions are unique. Additionally, RAG will provide learners with highly accurate and contextually relevant responses, helping them better understand complex topics and refine their knowledge effectively.

Edux combines advanced technologies, interactive tools, and personalized features to create a comprehensive learning platform. Its focus on structured learning paths, time management, and collaboration between learners and instructors makes it an effective tool for education.

1.2. High-Level System Architecture & Components of Proposed Solution

1.2.1. System Components



[Figure 1: Edux Component Diagram](#)

1.2.1.1. Client Layer

This layer represents the front-facing user interface (UI), interacting with various user roles and forming the entry point for system functionalities. We have the following roles:

Learners and Paid Tier Learners: Access general and premium learning content, respectively.

Instructors: Manage and create course materials, interact with learners.

System Administrators: Oversee the overall system functionality, manage user permissions, and handle maintenance.

The UI Component (with the help of API Gateway) connects the client roles with the backend, enabling seamless communication.

1.2.1.2. Skill Tree Layer

This specialized layer manages learning progression and personalized content delivery.

Skill Tree Generation Model: Dynamically generates personalized learning paths for learners.

Skill Tree Recreate Model: Handles updates or regeneration of learning paths based on user progress.

LLM Service: Supports intelligent recommendations or AI-driven content, likely integrating natural language capabilities to enhance user experience.

1.2.1.3. Backend Layer

Authentication Service: Verifies the token of each API call to each service, therefore it interfaces with all other services. Ensures API security.

Chat Service: Chat and Individual Study have a many-to-one relationship, meaning an Individual Study has many chats. Chat Service has endpoints for redirecting user messages to the LLM service, operating the creation of quizzes and flashcards by interfacing with the File Manager Service and the LLM Service, and finally uploading lecture slides by interfacing with the File Manager Service. Uses Chat DB as its database.

LLM Service: Interfaces with LLM API such as Gemini and ChatGPT to create quizzes, flashcards and send questions.

Skill Tree Service: Generates skill tree based on the keywords extracted from either chat data, file uploads, or provides predetermined skill trees with predetermined topics about different topics of interest. Interacts with the LLM service to generate quizzes with each node in the skill tree. Interacts with the File Manager Service to extract files and content.

Notification Service: A system that enables the delivery of messages or alerts to users or applications, ensuring timely communication of important information.

File Manager Service: Has endpoints for storing files in a distributed file system and for querying those files. It interfaces with many other services to manage files like slides, syllabi, flashcards, quizzes, etc.

Code Report Checker Service: It utilizes a trained model to evaluate the consistency between submitted code and accompanying reports. It processes student submissions by validating file formats and parsing both the source code and report for analysis. The system applies natural language processing (NLP) techniques to extract methodologies, algorithms, and results from the report. A comparison algorithm assesses alignment between the extracted report content and the analyzed code, based on predefined metrics such as logical correspondence, completeness, and

accuracy of described results. The system generates structured output detailing discrepancies and alignment scores, which are logged in a database.

Individual Study Service: Has many chats, a study plan, a syllabus, and an image associated with it. It interfaces with the File Manager Service to manage the study plan, syllabus and its image.

User Service: Manages user information and uses the User DB as its database. A user has many individual studies and skill trees associated with them. This service works closely with the authentication service to provide the current user for each API endpoint.

1.2.1.4. Data Layer

This layer handles the storage and retrieval of data essential for system operations:

User DB: Stores user information, credentials, and profiles, and is updated via the User Service.

Chat DB: Logs messages and interactions for the chat service, and it is updated through the Chat Service.

Individual Study DB: Tracks personalized learning progress and resources for users, and is updated by the Individual Study Service.

Skill Tree DB: Maintains skill tree configurations and user progress, and is updated by the Skill Tree Service.

Code Report Checker DB: Stores coding submissions, evaluations, and feedback, and is updated by the Code Report Checker Service.

1.2.2. Resources

Edux utilizes a variety of resources to enhance the educational experience as it aims to become a comprehensive and adaptable learning platform. This section outlines the key components that drive Edux's functionality and effectiveness. From user inputs that form the foundation of interactive learning tools to advanced technology resources that power seamless operations, each element plays a crucial role in delivering a personalized and efficient learning environment. Additionally, the platform's learning materials and monetization strategy ensure that Edux remains sustainable and accessible, providing robust support for learners at all levels.

1.2.2.1. User Inputs and Learning Materials

User inputs are a fundamental reason why Edux is such a personalizable education tool. They form the core of Edux's functionality, encompassing both the content uploaded by learners

and the tasks provided by instructors. Learners can upload study materials such as textbooks, PDFs, slides, and syllabi, which are then processed to create personalized tools like personalized study plans, flashcards, quizzes and skill trees. Instructors contribute tasks, including assignments and coding projects, that facilitate collaborative learning and evaluation.

1.2.2.2. Technology Resources

Currently, Edux utilizes the Gemini-Flash API. In the future, we aim to integrate APIs from providers like OpenAI or Hugging Face to enhance content summarization, question generation, and explanation tools. Additionally, we plan to leverage cloud services such as AWS to provide scalable solutions for hosting, data storage, and processing. However, when using APIs like ChatGPT, token usage becomes a critical cost factor, which will be discussed in the following section.

1.2.2.3. Monetization Strategy

To maintain financial sustainability, Edux incorporates a revenue model that includes paid subscription tiers. These tiers provide advanced features. One such feature we have envisioned is RAG, which would generate unique practice questions and provide high-accuracy explanations. The revenue generated from subscriptions is designed to cover operating costs, including the expenses associated with token usage for APIs like ChatGPT. This strategy ensures that Edux remains accessible while sustaining its operational and developmental needs.

1.2.3. Outputs

1.2.3.1. Generated Learning Tools

Edux creates personalized learning aids tailored to the user's uploaded content. Flashcards are designed to break down complex topics into digestible pieces, while quizzes provide a dynamic way to assess understanding and reinforce learning. Skill trees offer a structured visualization of learning paths, allowing learners to track their progress and achieve their goals systematically. Personalized study plans assist learners in managing their time more effectively. These tools transform raw content into interactive and goal-oriented resources.

1.2.3.2. Instructor Feedback

Edux enables instructors to assess and provide feedback on student submissions effectively. Automated evaluation models analyze submissions to ensure alignment between theoretical components (e.g., reports) and practical elements (e.g., code). This feature not only promotes academic integrity but also reduces the workload for instructors, allowing them to focus on teaching and mentorship.

1.3. Constraints

1.3.1. Implementation Constraints

The implementation of Edux faces some challenges related to technology, scalability, content accuracy, and privacy. From a technology perspective, working with large amounts of data, like long textbooks or detailed syllabi, using LLMs requires a lot of computational power. This can slow down response times and affect the user experience, especially when the system has to process complicated tasks. Supporting different types of files, such as images, slides, PDFs, and audio, needs advanced tools to analyze the content accurately, and this can be more difficult with different types of files. Features like creating personalized study schedules or explaining content in real time depend on strong server and backend systems, which might struggle during peak usage.

Scalability is an important part of Edux's design because the platform needs to handle many users at the same time, especially in academic peak periods such as exam seasons. The system's setup must be able to handle this increase in users smoothly and allow adding new features, like voice recording, without causing problems for the current services.

Ensuring the accuracy and relevance of content created by Edux, like flashcards, quizzes, and skill trees, is another big challenge. The platform needs to make sure these learning tools match the materials uploaded by users and keep their educational quality. This is especially important to maintain consistency between what students submit and what instructors assign, as any differences could negatively affect the learning experience.

Finally, user privacy and security are also very important when dealing with sensitive educational materials, performance or usage data, and interactions between instructors and students. Edux needs to follow strict data protection laws, like KVKK and GDPR, and use secure login systems to prevent unauthorized access. These constraints set the limits for how Edux can work, aiming to balance new ideas with what is realistic and possible.

1.3.2. Economic Constraints

The development and implementation of Edux are shaped by several economic constraints, including development costs, running expenses, earning strategies, managing resources, and getting educational institutions to adopt the platform. The initial development phase requires a lot of funding to build features like LLM-based tools, interactive learning aids, and personalized scheduling systems. A large part of this investment goes toward securing strong cloud infrastructure to support the platform. In addition, licensing or creating custom machine learning models can add high one-time and ongoing expenses, increasing the financial pressure during the early stages.

Handling large amounts of user-uploaded data and providing real-time feedback requires expensive resources. For example, operating machine learning models and frequently using APIs from big LLM providers adds to the ongoing costs for cloud services and computational needs.

Operational costs represent another critical constraint. Hosting and maintaining a platform capable of processing large volumes of user-uploaded content while delivering real-time feedback requires expensive resources. A significant portion of these costs arises from running machine learning models and making frequent API calls to LLM providers to deliver real-time responses.

Monetization is another challenge because Edux needs to be affordable for students and schools while still being financially sustainable. If the platform relies on subscriptions or tiered pricing, it might become less accessible to users with limited financial resources, reducing its impact.

Proper resource management is very important to focus on the features that matter the most. For example, adding voice recording or customizing skill trees might be prioritized to avoid spreading resources too thin, especially during the early stages of development.

Convincing schools and teachers to use Edux is another challenge. This might require heavy spending on marketing and providing training support, which increases both financial and time requirements. These financial challenges shape how Edux can grow and scale, making good financial planning and smart resource use key for its long-term success.

Finally, Convincing schools and teachers to use Edux is another challenge. This might require heavy spending on marketing and providing training support, which increases both financial and time requirements. These economic constraints shape the development and scalability of Edux, requiring careful financial planning and resource management to ensure long-term success.

1.3.3. Ethical Constraints

The development and deployment of Edux face several ethical challenges, including academic integrity, bias, data privacy, accessibility, and instructor oversight. Maintaining academic integrity is critical, as the platform must ensure its tools are not misused by students, such as relying on LLMs to complete assignments dishonestly. Additionally, the evaluation system designed to identify discrepancies between elements like code and reports must be accurate and fair, ensuring students are not unfairly penalized for legitimate differences in their work.

Another important ethical challenge is addressing bias and ensuring proper representation. The platform must ensure that content generated by LLMs—such as quizzes, flashcards, and

study guides—is free from unintentional stereotypes, biases, or errors that might marginalize or misrepresent certain groups of learners. Inclusivity is crucial to deliver equal value to all users, making sure that the study materials are suitable and effective for learners from different backgrounds and perspectives.

Data privacy is a vital ethical responsibility that demands strong measures to protect user-uploaded educational content from unauthorized access, misuse, or commercial exploitation. Clear and transparent communication about data usage policies is essential to establish trust, ensuring that users are fully informed and give their consent before any data is collected or processed.

Accessibility is another key ethical responsibility. The platform must be built to support users with disabilities by including features like screen reader compatibility and alternative input options. Moreover, tools for personalized scheduling and recommendations should be designed to respect different learning speeds and individual circumstances, avoiding generic approaches that could disadvantage certain learners.

Last, Edux must carefully balance instructor oversight with learner independence. The platform's tools should support and complement the role of instructors, rather than replacing or undermining their guidance in the learning process. By addressing these ethical challenges, Edux can foster a fair, inclusive, and responsible learning environment that respects the needs and rights of its users.

1.4. Professional and Ethical Issues

The development and deployment of Edux involve various ethical and professional considerations that must be carefully addressed. Protecting data privacy and security is a top priority, as users will upload sensitive academic materials, which may include proprietary or copyrighted content. Compliance with copyright laws and intellectual property rights is essential to prevent unauthorized use or redistribution of such materials.

The integration of LLMs presents ethical challenges, particularly in ensuring the accuracy and reliability of the content generated. Errors in explanations could mislead users, so it is important to provide transparency about the limitations of AI-generated content to maintain user trust and prevent misuse. The platform's features for generating personalized schedules and assessments must be designed to avoid biases that could unfairly impact certain user groups.

The feature for evaluating the alignment between submitted reports and assigned code must be carefully implemented to avoid excessive reliance on automated tools. Over-reliance could undermine critical thinking and problem-solving skills if the tools are not thoughtfully integrated into the educational process.

Pay tiers must be structured ethically to ensure that advanced learning tools remain accessible to all users, regardless of their socio-economic status, thereby avoiding creating barriers to equitable education.

Finally, the user-instructor collaboration feature must include safeguards to prevent misuse and ensure that interactions promote fairness and contribute positively to the learning experience for both students and instructors. By addressing these ethical and professional considerations, Edux can uphold its commitment to providing a responsible and inclusive educational platform.

1.5. Standards

The development of Edux follows strict standards in usability, accessibility, security, and technological integration to create an effective and reliable educational platform. Usability is achieved through an intuitive design and user-focused features, making it easy for learners with different levels of technical expertise to use the platform effectively. Accessibility is a priority, ensuring the platform complies with guidelines to support inclusive learning for individuals with diverse needs and abilities.

Security is handled with industry-standard measures, including end-to-end encryption for protecting user data, strict adherence to GDPR regulations for data protection, and strong authentication protocols to maintain privacy and data integrity. Technological standards focus on scalability and reliability, utilizing cloud infrastructure, modular code architecture, and advanced language models for better content analysis and interaction.

The platform's development adheres to best practices in the software development life cycle, including version control, continuous integration and deployment (CI/CD), and thorough testing to ensure functionality, performance, and reliability. All features are built with future growth in mind, enabling the integration of advanced tools like RAG and voice-processing capabilities without disrupting existing functionality. These standards define Edux as an effective tool for both learners and instructors.

2. Design Requirements

2.1. Functional Requirements

The functional requirements of Edux define the core capabilities necessary to deliver its intended features and user experience effectively. These requirements span user management, content processing, interactive learning tools, personalized scheduling, collaboration, analytics, and other essential functionalities.

2.1.1. User Management and Authentication

Edux must support multiple user roles, including learners, instructors, and administrators, each with distinct functionalities. Each user will be registered to the system and saved to the database with a unique ID. Also, secure authentication mechanisms are required, enabling users to log in or register using email, passwords, or third-party integrations like Google or Microsoft accounts. Additionally, the platform should provide comprehensive account management, allowing users to update profiles, reset passwords, and configure preferences with their unique user ID.

2.1.2. Resource Upload and Processing

A critical feature of Edux is its ability to process various types of educational materials. Users should be able to upload resources in multiple formats, such as PDFs, images, presentations, and text documents. Advanced content parsing is required to extract and analyze textual data from these uploads. The platform must offer explanations either on a page-by-page basis or across entire documents. Future enhancements include voice integration, allowing learners to upload or record voice notes for transcription and further analysis.

2.1.3. Interactive Learning Tools

Edux uses interactive tools to enhance learning. It automatically generates flashcards from uploaded materials, highlighting key concepts, while allowing users to customize or create their own linked to their unique ID. The quiz feature supports multiple formats, including multiple-choice, fill-in-the-blank, and short answers, to reinforce learning. Skill trees, both predefined and customizable, visually guide users through hierarchical learning paths, offering structured and flexible educational experience.

2.1.4. Personalized Study Schedules

The ability to generate personalized study schedules is a cornerstone of Edux. Schedules should be based on uploaded syllabi or manually entered data, with dynamic adjustments informed by performance in quizzes and time spent on tasks with their unique user ID. The platform should identify areas of weakness, allocate study time accordingly, and send notifications about deadlines, progress milestones, or missed sessions to keep learners on track.

2.1.5. Instructor-Student Collaboration

For students, Edux offers collaborative tools to enhance the learning process. Instructors should be able to assign tasks, including reports and coding projects, and use evaluation tools to ensure alignment between theoretical and practical components with their unique user ID and roles.

2.1.6. Reporting and Analysis

Edux must generate comprehensive reports to help learners and instructors track performance. Learners should receive insights into their progress, strengths, and areas needing improvement, while instructors should have access to dashboards detailing class performance, task completion rates, and individual student metrics. Time analytics will correlate learning activities with performance, enabling data-driven adjustments.

2.1.7. Learning Assistance with LLMs

The platform's integration of large language models is central to its functionality. Edux will provide detailed, context-aware explanations of uploaded content and support natural language queries, allowing learners to ask questions and receive precise answers. This enhances the understanding and retention of complex material.

2.1.8. Accessibility and User Interface

Ensuring accessibility is crucial for a diverse user base. Edux must feature a responsive design compatible with desktops, tablets, and smartphones. Accessibility features, such as screen reader support, adjustable font sizes, and high-contrast settings, will improve usability for individuals with disabilities. Multilingual support is also essential to serve users across different linguistic backgrounds. If the correct unique identifier is provided to the system, the corresponding materials will be supplied to the user (i.e., the files associated with that username and password will be delivered).

2.1.9. Data Security and Privacy

Robust security measures are essential to protect sensitive data. Encryption should safeguard user-uploaded files and personal information during transmission and storage. Role-based access control will ensure that only authorized users can view or manage specific data. Compliance with data protection regulations, such as GDPR, is mandatory to maintain user trust and legal conformity. Requests for course material that do not correspond to the unique ID will be declined.

2.1.10. Scalability and Performance

To ensure a seamless experience, Edux must maintain high availability during peak periods, such as exam seasons. Scalable infrastructure will accommodate growth in user numbers and uploaded content without performance degradation. Optimization techniques, including caching and efficient query handling, are critical for maintaining responsiveness and reliability.

2.2. Non-Functional Requirements

2.2.1. Usability

Edux is designed for learners requiring a user-friendly interface that is intuitive, accessible, and easy to navigate. The platform must cater to the diverse needs and preferences of its users. Key usability features should include clearly labelled buttons accompanied by text or universally recognized icons to ensure clarity. The user interface (UI) should be compact and responsive, allowing students to efficiently access tools and resources, especially during busy study periods. The system shall ensure that 95% of users can complete common tasks, such as uploading content or generating flashcards, within 3 clicks or fewer.

2.2.2. Reliability

Ensuring no loss of data integrity in case of system failures is crucial, as these losses can be real-time data entries that have not been committed to the database and could be at risk during system failures. The system should maintain a data consistency rate of at least 99.9%, ensuring that data remains consistent and accurate even during system failures. Scheduled maintenance should be conducted during periods of minimal user activity to minimize disruption. Ensuring that user data is protected during interactions with API gateways and safeguarded against cyber-attacks is crucial. The system should achieve an uptime of at least 99.9% annually, which translates to no more than 8.76 hours of downtime per year.

2.2.3. Performance

Database queries, such as loading individual study materials in the chat screen and generating skill trees, flashcards, and quizzes, as well as reloading skill trees, should return results within milliseconds to a few seconds, depending on the complexity and size of the data, to ensure an optimal user experience. For instance, a query handling a few hundred records should ideally be completed in under 100 milliseconds, while more complex queries involving millions of records might take a few seconds. This order of magnitude ensures that users experience minimal delay, maintaining a responsive and efficient system. Moreover, Edux will utilize visual indicators to notify users during longer loading times and manage expectations. The average response time should not exceed 2 seconds under normal conditions and should not exceed 3 seconds during peak loads.

2.2.4. Supportability

The application must be accessible and function seamlessly across various devices and operating systems, including desktops, mobile phones, and tablets integration in the future scope of the project. The application should be compatible with at least 95% of the most commonly

used devices. Support processes must align with industry standards and regulatory requirements, ensuring data security and user trust.

2.2.5. Scalability

Edux should seamlessly scale to accommodate increasing user traffic and a growing database of study materials. The system should be designed to handle higher loads without compromising performance or usability. An example metric to track Edux's ability to handle higher loads without compromising performance or usability is system throughput, measured in transactions per second (TPS). This metric captures the volume of transactions the system can process within a given timeframe, reflecting performance and scalability under varying loads. This approach can provide early detection of issues and proactive scaling. Moreover, the system shall handle at least 1000 simultaneous users without performance degradation.

3. Feasibility Discussions

3.1. Market & Competitive Analysis

Edux enters a competitive landscape of AI-powered learning platforms that offer personalized study aids and resource management. Platforms like Studyfetch and Mindgrasp.ai provide features such as AI-generated notes, flashcards, and quizzes, enabling users to transform their study materials into interactive learning tools. Similarly, Flint offers personalized tutoring and automated study assistance, focusing on efficiency and engagement.

In addition to content generation, Edux's feature of personalized study schedules positions it alongside platforms like Studyfetch's AI Study Plan Creator, which generates tailored study plans based on user input. This functionality addresses the need for effective time management and targeted learning, a common requirement among learners. By integrating personalized scheduling with content generation, Edux aims to provide a holistic learning experience that adapts to individual needs.

Edux's unique proposition lies in its planned integration of RAG for creating unique practice questions and its focus on aligning theoretical knowledge with practical application through instructor-assigned tasks. This approach distinguishes Edux from competitors by emphasizing academic integrity and the practical application of knowledge. By combining advanced AI technologies with interactive tools and personalized features, Edux seeks to offer a comprehensive learning platform that enhances understanding and retention and ensures consistency between theory and practice.

3.1.1 Studyfetch

StudyFetch is an AI-driven educational platform that transforms course materials— PDFs, PowerPoints, and lecture videos—into interactive study tools like flashcards, quizzes, and detailed notes. It features Spark.E, a personalized AI tutor available 24/7 to assist with real-time learning and provide immediate feedback. StudyFetch also offers functionalities like essay grading, lecture transcription, and customizable study sets to enhance learning efficiency and effectiveness [1].

In comparison, Edux shares similarities with StudyFetch in its use of AI to process diverse study materials and generate interactive learning aids such as flashcards and quizzes. However, Edux distinguishes itself by incorporating unique features like skill trees for structured learning paths, personalized study schedules based on individual syllabi, and a focus on fostering collaboration between learners and instructors. Additionally, Edux plans to introduce advanced functionalities, including RAG for creating unique practice questions and ensuring consistency between theoretical knowledge and practical applications. These elements position Edux as a comprehensive platform tailored to personalized and structured learning experiences.

3.1.2 Flintk12

Flint is an AI-driven platform designed to personalize learning experiences within educational institutions. It enables teachers to create customized AI activities that cater to individual student needs, offering immediate feedback and tailored support across various subjects and grade levels. Flint's AI can process diverse materials, including text documents, websites, and code snippets, to generate relevant content and assessments. The platform also supports interactive features like speech-to-text and text-to-speech, enhancing accessibility for students with different learning preferences. Additionally, Flint integrates with school information and learning management systems, streamlining class roster management and facilitating seamless adoption within existing educational frameworks [2].

Edux offers a comprehensive suite of tools to enhance individual learning and assessment. By allowing learners to upload various study resources, Edux utilizes large language models to provide detailed explanations and interactive learning aids such as flashcards, quizzes, and skill trees. The platform emphasizes personalized study schedules and plans to incorporate features like RAG to create unique practice questions. While both platforms leverage AI to support personalized learning, Flint focuses on empowering educators to tailor AI-driven activities within a school setting, whereas Edux centers on providing learners with tools to manage and enhance their study experiences independently.

3.1.3 Mindgrasp.ai

Mindgrasp.ai is an AI-powered learning assistant designed to enhance the educational experience by transforming various types of content into study aids. Users can upload documents, PDFs, videos, and audio recordings, which Mindgrasp processes to generate detailed notes, concise summaries, flashcards, and quizzes. The platform also features an interactive AI tutor capable of answering questions related to the uploaded content, facilitating a deeper understanding of the material. Additionally, Mindgrasp supports over 20 languages, making it accessible to a diverse user base [3].

In comparison, Edux offers a more structured approach to learning by incorporating features like skill trees and personalized study schedules. While both platforms provide tools such as flashcards and quizzes, Edux emphasizes time management and progress tracking through customized study plans based on individual syllabi and assessment performance. Furthermore, Edux plans to introduce RAG to create unique practice questions and facilitate collaboration between learners and instructors, particularly in engineering education. This focus on structured learning paths, time management, and instructor-student interaction distinguishes Edux from Mindgrasp's content transformation and AI tutoring capabilities.

3.2. Academic Analysis

3.2.1. Constructivist Learning Theory

Edux aligns with constructivist learning theory, which emphasizes the importance of active learning, where learners build their understanding through active engagement with the material. Features such as interactive quizzes, flashcards, and skill trees support this approach by encouraging active participation [4].

3.2.2. Personalized Learning

A central aspect of Edux is its ability to personalize the learning experience. This is done by tailoring individual needs based on learners' performance, the time to complete the assessments and study schedules [5]. By adjusting the pace and type of resources offered, the platform aims to cater to both fast learners and those who require additional support.

3.2.3. Technological Trend

The use of LLMs in Edux for real-time content explanation aligns with emerging trends in educational technology. As the Encoding Specificity Hypothesis states, learning improves when examples align closely with the learner's context, Edux harnesses LLMs' explanations as examples. This approach delivers superior interactivity, adaptability, and effectiveness, outperforming traditional methods and human-crafted examples [6].

3.2.4. Data Privacy and Ethical Considerations

Like any educational platform, Edux must address data privacy and ethical concerns, particularly given the use of AI and personalized data. Adhering to standards like GDPR and data protection protocols is essential to maintaining user trust. Ethical use of AI, particularly in personalized recommendations and assessments, must also be considered, ensuring that algorithms are transparent, unbiased, and fair to all users [7].

4. Glossary

LLM: Large language model

A Large Language Model (LLM) is an advanced artificial intelligence system trained on extensive text datasets to understand and generate human-like language. These models are pivotal in natural language processing tasks, including text generation, translation, and sentiment analysis.

API: Application programming interface

An Application Programming Interface (API) is a set of protocols and tools that allow different software applications to communicate with each other. APIs enable developers to access specific functionalities or data from external services without needing to understand their internal workings.

RAG: Retrieval augmented generation

Retrieval Augmented Generation (RAG) is a technique that combines large language models with external data sources to enhance the accuracy and relevance of generated content. By retrieving pertinent information from databases or documents, RAG systems can produce more informed and contextually appropriate responses.

GDPR: General data protection regulation

The General Data Protection Regulation (GDPR) is a comprehensive data protection law enacted by the European Union to safeguard individuals' personal data and privacy. Implemented in 2018, it imposes strict guidelines on data collection, processing, and storage, with significant penalties for non-compliance.

TPS: Transactions per second

Transactions Per Second (TPS) is a metric used to measure the number of transactions a system can process in one second. It's commonly used to assess the performance and scalability of databases, networks, and other transactional systems.

ID: Identifier

An Identifier (ID) is a unique symbol or sequence assigned to an entity to distinguish it from others. IDs are essential in databases, programming, and various systems to reference and manage specific records or objects efficiently.

5. References

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