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An Empirical Study for the Dynamic and Personalised Learning Experience of the AI Course Generator

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Abstract— In a world that is quickly evolving, the demand for continuous learning and upskilling is critical for personal and professional growth. However, many learners struggle to create personalised, efficient learning paths tailored to their unique needs due to the limitations of traditional course creation methods, which require significant human input and expertise. This project aims to address this problem by developing "*modulo*," an innovative platform designed to automate the creation of personalised and structured learning paths. The objectives of "*modulo*" are to leverage artificial intelligence and external APIs to generate customised study plans for any chosen subject, integrate curated YouTube tutorials and supplemental materials, and enhance the learning experience with adaptive quizzes tailored to user progress. The methodology follows an Iterative-Waterfall approach, combining structured phases with iterative cycles to incorporate feedback and adapt to emerging challenges. The system architecture is built on a microservices framework, with a frontend developed using React and Next.js, and a backend supported by Supabase with Prisma for database management, NextAuth for user authentication, and Stripe for payment processing. The result is a scalable and maintainable platform that empowers diverse user groups by enhancing education accessibility. "*modulo*" provides a dynamic and personalised learning experience, making a meaningful impact on self-directed learning.

Keywords— AI, APIs, educational technology, course generation, personalised learning experience.

I. INTRODUCTION

In today's environment of fast change, continuous learning and upskilling are essential for personal and professional growth. While online learning platforms like Udemy, Coursera, and Khan Academy offer extensive resources, many learners struggle to create personalised, efficient learning paths tailored to their unique needs. Traditional course creation methods require significant human input and expertise, making it challenging to meet individual learner requirements effectively. This project introduces "*modulo*", an innovative platform designed to transform the self-study experience by automating the creation of personalised learning paths. Leveraging artificial intelligence (AI) and machine learning, *modulo* generates customised study plans based on user-selected topics, integrating relevant YouTube tutorials and supplemental materials. The platform enhances learning with adaptive quizzes, tailored to user progress, to reinforce understanding of key concepts.

Our project aligns with the Sustainable Development Goal (SDG) 4, which underscores the importance of quality education. SDG 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all [1]. By providing a dynamic and personalised learning experience, *modulo* contributes to making education more accessible and tailored to individual needs, supporting lifelong learning and educational equity.

The key objectives of the project are as follows:

- Automating course generation using AI algorithms.
- Curating relevant content through application programming interface (API) integrations.
- Implementing adaptive quizzes to verify and solidify learning.
- Creating an intuitive user interface for seamless interaction.

II. REVIEW OF PREVIOUS WORKS

In recent years, the field of educational technology (EdTech) has experienced rapid growth and innovation, with advancements in various technologies reshaping the landscape of teaching and learning. This review of previous works delves into two key subtopics driving this evolution: Trends and Advancements of Technology in Education, and Integration of AI in Educational Platforms. Through an examination of these subtopics, this review aims to summarise and provide valuable insights into the current state of EdTech and its implications for the future of learning.

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A. *Trends and Advancements of Technology in Education*

Recent advancements in EdTech have significantly impacted teaching and learning. Some of the key trends include:

1) *Artificial Intelligence*

One of the most prominent trends in EdTech is the integration of AI into educational platforms and systems. AI has the power to completely change how we educate, learn, and evaluate the progress of our students [2]. AI-powered tools and applications, such as chatbots, virtual tutors, and personalised learning systems, are revolutionising how educators deliver instruction and how students engage with course materials.

2) *Immersive Technologies*

Another significant trend is the growing use of immersive technologies, including virtual reality (VR) and augmented reality (AR), in education. VR and AR technologies offer immersive, interactive learning experiences that allow students to explore virtual environments, conduct experiments, and engage with complex concepts more tangibly and engagingly. While augmented reality allows teachers to lead their students through 360° views and 3D objects, virtual reality allows the exploration of the complete universe virtually [3].

3) *Gamification*

Saleem, Noori, and Ozdamli [4] highlight in their literature review that gamification can serve as an effective tool for acquiring knowledge and enhancing critical capabilities such as decision-making, cooperation, and communication. Gamified learning platforms achieve this by incorporating game elements, such as points, badges, and leaderboards, into educational activities to incentivise participation and foster a sense of achievement.

It is crucial to remain informed about emerging trends in EdTech, including AI, VR & AR, and gamification, which present fresh possibilities for personalised and immersive learning encounters [5]. Thus, to fully harness the benefits of technology in education, educators, policymakers, and stakeholders must address the challenges and considerations associated with its implementation and ensure that technology-enhanced learning remains inclusive and learner-centred.

B. *Integration of AI in Educational Platforms*

AI integration in educational platforms offers transformative opportunities. Recent developments include:

1) *Automated Course Generation*

AI-driven educational platforms leverage machine learning algorithms, natural language processing (NLP), and other AI technologies to provide personalised learning experiences, automate administrative tasks, and facilitate real-time feedback and support for learners. Wijerathne et al. [6] introduced "Create-My-Course," an automated platform tailored for self-paced programs in asynchronous e-learning. The platform utilises AI algorithms to automate course generation processes, including video segmentation, transcription, lecture note generation, question creation, and past paper suggestions.

2) *Personalised Learning*

It is also valuable to consider any existing platforms that utilise AI technology to automate course generation processes. AI-driven platforms such as Coursebox [7] and Courseau [8] demonstrate the practical applications of AI in course creation, highlighting the potential for personalised and adaptive learning experiences. A comparison of the features of Coursebox, Courseau and our AI Course Generator, *modulo* is shown in Table 1 below.

TABLE 1 COMPARISON OF FEATURES BETWEEN COURSEBOX, COURSEAU AND *MODULO*

Features	Coursebox	Courseau	*modulo*
Personalised course outlines and study plans.	✓	✓	✓
Written material such as essays, summaries, and transcriptions.	✓	✓	✓
Curated video tutorials	✗	✗	✓
Adaptive quizzes	✓	✓	✓

Video tutorials can be viewed as part of a sophisticated electronic teaching strategy, which becomes more effective when combined with other techniques and tools [9]. While Coursebox and Courseau demonstrate the versatility and capabilities of AI technology in automating course creation processes, they lack the integration of video tutorials, which are an important component of modern learning experiences. Our AI Course Generator addresses this gap by incorporating the YouTube API to find and curate the best and most relevant video tutorials for each course. This ensures that learners not only receive structured and personalised content but also benefit from high-quality visual aids that enhance understanding and engagement.

III. METHODOLOGY

A. *Iterative-Waterfall Approach*

We have carefully selected the Iterative-Waterfall technique, which is well known for combining the structured

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aspects of the waterfall approach with the flexibility of iterative cycles. The iterative waterfall model, also known as the mini-waterfall model, addresses the limitations of the traditional waterfall model [10]. This approach allows for continuous refinement and adaptation as we progress through the development lifecycle. The Iterative-Waterfall methodology maintains the organised and sequential phases of the Waterfall model while incorporating feedback loops and iterations to enhance adaptability and efficiency, which can be seen in Figure 1 below.

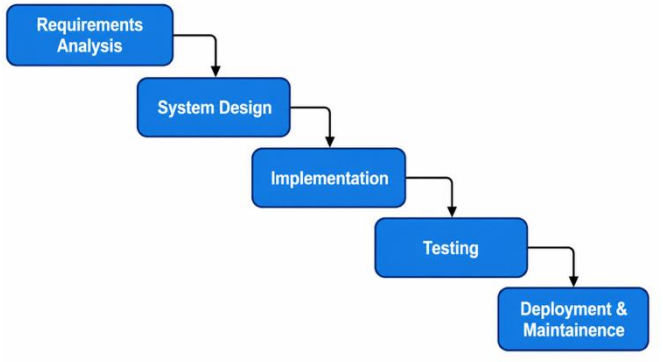

Fig. 1 Iterative-Waterfall Model

The next sections will examine each stage of our Iterative-Waterfall technique as it relates to our project, providing more detail on the particular tasks, approaches, and results included in each phase.

B. Requirements Analysis

The requirements analysis for the AI Course Generator platform was shaped by insights gathered from an online survey involving 50 respondents who were interested in self-directed learning platforms, with the majority being students and some professionals. These respondents expressed a strong inclination towards utilising online platforms dedicated to self-directed learning, underscoring the importance of structured learning paths and personalised study plans. Additionally, we identified the potential for leveraging various APIs to enhance the platform's functionalities, including Pexels for visual resources, OpenAI for intelligent interactions and content development, and YouTube for selected instructional content. These findings, coupled with users' expectations for features like automated course generation and adaptive quizzes, provide valuable guidance for the development of a user-centric and comprehensive learning platform.

Firstly, an online survey conducted with the 50 respondents provided valuable insights into user requirements, revealing a strong interest in self-directed learning activities, with 88% currently engaged in such pursuits. Furthermore, 90% expressed interest in utilising an online platform for self-directed learning, indicating a high demand for such services. The survey highlighted the importance of structured learning paths, with 84% considering it very important to have predefined subtopics and resources. Moreover, 98% of respondents preferred personalised study plans tailored to their interests and learning goals, emphasising the need for adaptive and customisable learning experiences. Essential features such as automated course generation, adaptive quizzes, and a user-friendly interface were prioritised, reflecting users' expectations for a seamless and intuitive learning environment.

The survey results highlighted key user requirements, such as the importance of 1) personalised study plans, 2) automated course generation, and 3) adaptive quizzes. Users also expressed a preference for 4) visually appealing interfaces and access to 5) supplemental materials/ content. The charts of the results of these features can be seen in Figure 2 and Figure 3. This has guided us to incorporate these features as requirements to be developed into the *modulo* platform.

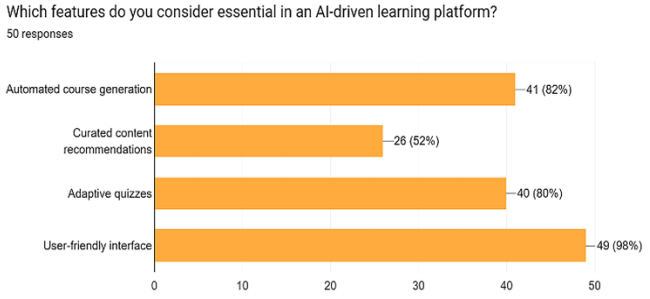

Fig. 2 Essential Features

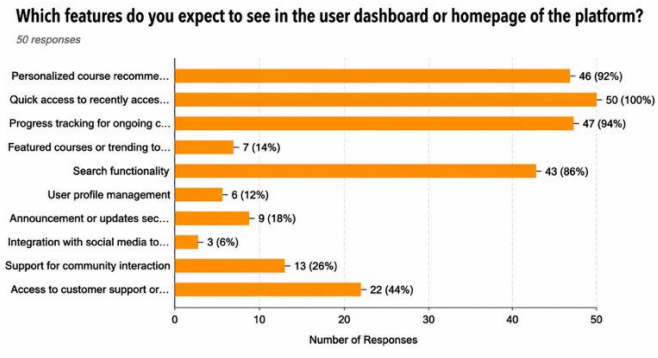

Fig. 3 Dashboard Features

Moreover, recognising the immense potential of API integrations, our project is poised to leverage these technologies to enhance the AI Course Generator's functionalities. Multiple APIs are integrated to enhance the platform's functionality. These APIs include Pexels for visual resources, OpenAI for intelligent interactions and content

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development, and YouTube for selected instructional content. These APIs will be essential building blocks for creating a thorough learning ecosystem on our platform.

The requirements analysis process has provided essential insights into user preferences and technological opportunities. With a clear vision informed by user feedback and technological advancements, the project is poised to deliver a transformative learning experience tailored to the needs of self-directed learners.

C. System Design

Outlining the system architecture, database design, and technological components required for the development and implementation of our website is the focus of our System Design phase.

1) System Architecture

A microservices architecture will be used in the development of our website to ensure scalability, maintainability, and effective performance. The core components include:

- Frontend Framework: Utilising Next.js for client-side rendering, TailwindCSS for styling, and shadcn for component management.
- Backend Infrastructure: Employing Supabase with Prisma for a cloud-hosted SQL managed database, integrated with NextAuth for user authentication and payment via Stripe.
- Deployment & Hosting: Deployment will involve pushing the project to GitHub for version control and deploying on Vercel for seamless integration with Next.js. The GPT API server will be hosted on a dedicated Linux server. Continuous monitoring, regular updates, and user feedback integration will ensure optimal performance and user experience.

2) Component Details

The frontend components of the AI Course Generator platform include several key features. The Sign Up and Login functionality, powered by NextAuth, ensures secure user authentication, allowing users to register and log in. The Dashboard/Library displays curated courses and user-specific recommendations, providing easy navigation for an optimal exploration experience. The Create Course Page would enable users to select topics of interest and generate personalised study plans using AI & API algorithms. Once generated, the Course Page showcases the complete course structure, including all modules and their respective lessons. Finally, the Lesson Page presents the lesson content, such as videos and summaries, and includes adaptive quizzes for each lesson to reinforce learning.

The backend components of the AI Course Generator platform are designed for efficiency and security. Database management is handled using Supabase with Prisma, which ensures secure storage of user data, course structures, and user preferences. NextAuth is integrated with Stripe to provide secure user authentication and manage subscription and payment features. Additionally, the platform leverages external APIs such as Pexels for visual resources, OpenAI for content development, and YouTube for tutorial content, enriching the overall learning experience.

3) Data Flow & Integration

The user flow and interaction sequence for the AI Course Generator platform involves several steps, which are illustrated in a use case diagram (Figure 4) and a flowchart (Figure 5).

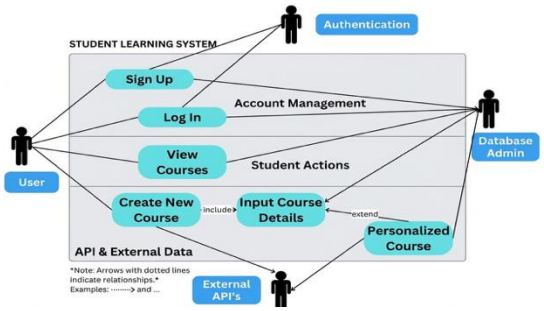

Fig. 4 Use Case Diagram

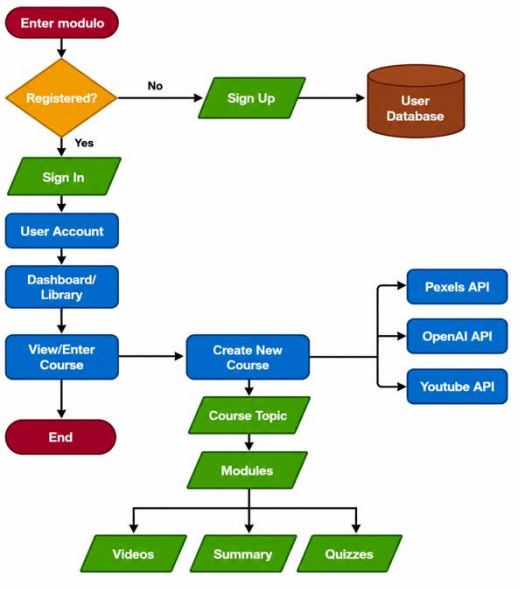

Fig. 5 System Design Flowchart

The sequence begins with user registration and login, followed by browsing and selection of topics. Next, the backend processes these requests, utilising AI algorithms to

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generate personalised courses and fetch relevant content from integrated APIs. Once the course is generated, it is displayed for the user. Finally, users can view the course and interact with quizzes, with the processed data sent back to the front end for display and interaction.

4) High-Fidelity Prototype

A horizontal high-fidelity prototype of the frontend components was created to visualise the user interface, navigation flow, and overall layout of the platform before actual development began. The prototype was fully coded using Next.js for client-side rendering, TailwindCSS for styling, and shadcn for component management.

D. Implementation

The implementation phase of the AI Course Generator project commenced with the development of the backend components, followed by enhancements to the frontend interface based on the high-fidelity prototype.

1) Backend Development

The backend development process utilised Supabase, a fully managed MySQL-compatible database platform that supports the growth of organisations of all sizes in a cloud-based environment. Supabase provided the foundation for storing and managing the project's data securely and efficiently. Additionally, Prisma ORM, a next-generation ORM (Object-Relational Mapping), was employed to facilitate seamless integration with Supabase. Prisma simplifies database interactions and makes working with databases easy for application developers, enhancing productivity in the backend development process.

a) Database Schema:

The database schema was designed to include model-tables such as Account, Session, User, UserSubscription, Course, Module, Unit, and Question, all interconnected to manage user data, course content, and subscriptions effectively. Figure 6 depicts the database schema that was created, illustrating the relationships between different models/tables. This schema outlines the structure of the database.

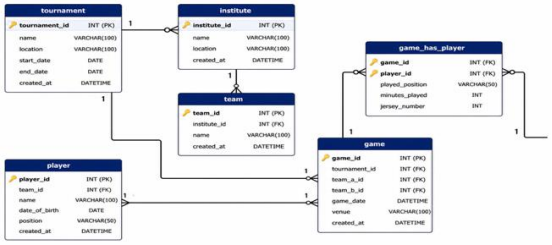

Fig. 6 Database Schema

b) Integration with External Services:

The Supabase database was also integrated with Stripe, a payments platform that enables businesses to accept credit cards, debit cards, and various popular payment methods globally, all through a single integration. Stripe provided robust payment processing capabilities, allowing the AI Course Generator platform to manage user subscriptions and control the number of course generations allowed per user seamlessly. Table 2 below shows the initial subscription plans that have been incorporated within the platform.

TABLE 2 INITIAL SUBSCRIPTION PLAN

	Free Users	Subscribed Users
Course Generations	Limited (5)	Unlimited

Furthermore, NextAuth, a flexible authentication and authorisation library, was integrated through the database to facilitate user authentication and streamline payment processing. NextAuth simplifies user authentication processes, providing a secure and user-friendly experience for accessing the platform's features and services.

c) Course Generation with APIs:

The course generation process leveraged the YouTube API and OpenAI API in tandem to create personalised courses. Firstly, users provided the topic/title and details of the course they desired, which were then sent to the OpenAI API to generate a study plan based on the input. This study plan encompassed the creation of modules, lessons, and quiz questions tailored to the user's preferences.

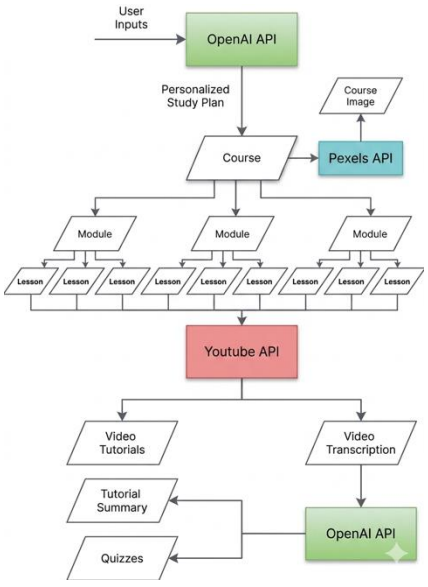

Fig. 7 Integration of All the APIs for the Course Creation Process

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In addition, the YouTube API was utilised to identify relevant videos for each lesson based on their transcription. The OpenAI API received the transcription of each lesson's video to generate summaries and formulate quiz questions and answers based on the video content. These questions and answers were then used to create quizzes in multiple-choice format for user interaction. Lastly, the Pexels API which is a provider of stock photography and stock footage was integrated to procure images for each course, enhancing the visual appeal of the dashboard/library interface. These images provided visual representation for different courses, improving user engagement and navigation. Figure 7 shows the integration of all the different APIs for the course creation process.

2) Frontend Development

Following the completion of backend development, attention was directed towards enhancing the frontend interface, as the core outline was already built as a high-fidelity prototype in the system design phase. Using Next.js with TailwindCSS, the user interface underwent significant improvements to enhance aesthetics, usability, and overall user experience. Screenshots of the revamped interface were captured to showcase the updated look and feel of the platform. Figure 8 to Figure 13 display the screenshots of the main pages of the *modulo* platform.

Fig. 8 Sign-Up Page

Fig. 9 Dashboard/Library Page

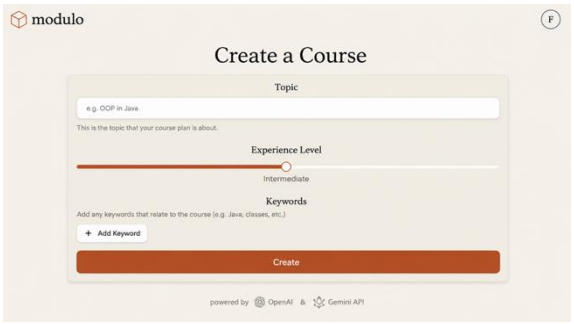

Fig. 10 Create a Course Page

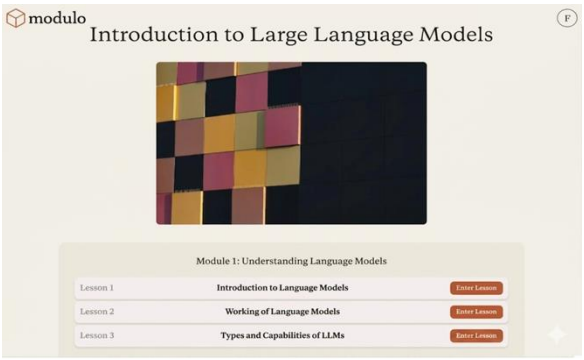

Fig. 11 Course Page

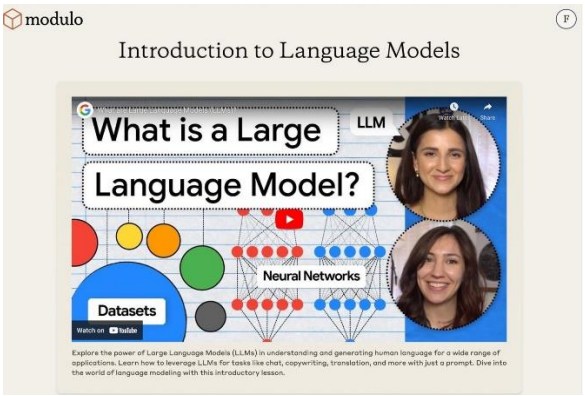

Fig. 12 Lesson Page video tutorials

The backend development focused on establishing a robust infrastructure for managing user data, course content, and subscriptions, while the frontend enhancements aimed to improve the visual appeal and usability of the platform. Together, these efforts contributed to the realisation of the AI Course Generator platform, providing users with a seamless and engaging learning experience.

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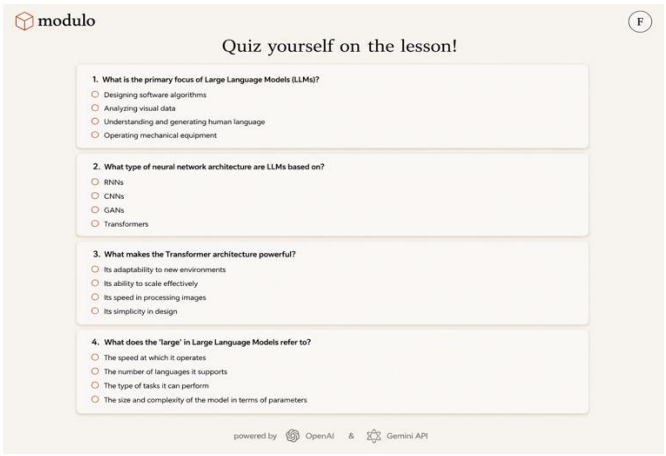

Fig. 13 Lesson Page quizzes

E. System Testing

A User Acceptance Testing (UAT) was performed for the testing of the system and to confirm that the platform worked as intended and that it is usable from an end-user perspective. The UAT was conducted face-to-face in IIUM Gombak Selangor, Kuala Lumpur, Malaysia, on May 18th. It involved 3 participants (students in the Department of Computer Science), who were already aware of our project background as they were already involved in the gathering of the user requirements. The UAT plan involved users performing all possible actions within the system with a record of the results.

1) Test Plan

The UAT test plan was organised to include all the components for comprehensive testing. The test plan was based on various scenarios, where a description of the scenarios is shown in Table 3 and a real example of a scenario is shown in Table 4.

TABLE 3 SCENARIO DESCRIPTIONS

Pages	Each page of the platform tested
Test Data	Specific test data were used to simulate realistic user interactions.
Test Condition	Various conditions under which users might interact with the system were considered.
Expected Result	For each test condition, an expected result was defined to establish the benchmark for successful functionality.
Actual Result	The actual outcomes were recorded to identify any discrepancies between expected and actual system behaviour.
Remarks	Observations and feedback from the users were noted to highlight areas of improvement or additional feature requirements.

TABLE 4 SCENARIO EXAMPLE

Pages	Test Data	Test Condition	Expected Result	Actual Result	Remarks
Course Page	N/A	Selected "Start Lesson" for any of the Lessons within a Module.	Redirected to the respective Lesson Page	☑	Worked as expected

2) Enhancements

The UAT was successfully completed, with all core features functioning as intended. However, based on user feedback and remarks, several areas for enhancement were identified to further improve the platform's usability and functionality. These enhancements included:

a) "Forgot Password" Feature

A new feature was added to the login page, allowing users who forgot their password to reset it easily. This enhancement aimed to provide a straightforward solution for password recovery which was lacking.

b) Additional Modules Post-Course Generation

Users expressed the need for flexibility in adding more modules even after a course had been generated. This feature was implemented to allow continuous course customisation, accommodating evolving learning needs.

F. Deployment & Maintenance

The deployment and maintenance phase ensured that our AI Course Generator platform, *modulo*, was not only successfully launched but also remained functional and up-to-date post-deployment. The first step involved pushing the entire project to a GitHub repository, ensuring that all code was version-controlled and easily accessible for further development and deployment processes. Subsequently, a Vercel account was created and linked to the project's GitHub repository. Vercel was chosen for its coherent integration with Next.js and its capabilities in automatic deployments.

The repository was then deployed on Vercel as a website, with necessary environment variables such as API keys and database connection strings configured to ensure the application could function correctly in the live environment. Following this, the GPT API server, responsible for handling OpenAI API calls, was pushed to a separate GitHub repository. This server forms the backend of our application, processing user requests and generating personalised content. Furthermore, a dedicated Linux server was used, where the latest commits from the GPT API server were

pulled and the server was made to handle API calls, ensuring that the AI functionalities of the platform were operational.

Post-deployment, the platform's maintenance involved continuous monitoring and updates to ensure optimal performance and security. Key maintenance activities included monitoring and logging the application's performance, applying regular updates to software components, libraries, and dependencies, and integrating user feedback into subsequent iterations to enhance functionality and user experience. These steps ensured that *modulo* was successfully deployed and maintained, providing a reliable platform for self-directed learners to generate and follow personalised learning paths.

IV. Conclusions

The development of the AI Course Generator platform, *modulo*, represents a significant advancement in self-directed learning. This project successfully addressed the challenge of creating personalised and structured learning paths by leveraging AI and machine learning technologies. Through the implementation of a microservices architecture, the platform ensured scalability, and efficient performance. The Iterative-Waterfall methodology employed during the development process allowed for continuous refinement and adaptation, ensuring that the final product met the needs and expectations of its users. The thorough requirements analysis, informed by a survey of potential users, guided the design and implementation phases, resulting in a user-centric and feature-rich platform.

Looking ahead, future work should consider the existing limited user testing on a small group of three participants only from the Department of Computer Science in the current study. Although their feedback is essential, conducting a more extensive testing phase with a bigger and more diverse set of users would yield a more comprehensive evaluation of the platform's usability and effectiveness. Increasing the number of users participating in testing could reveal additional insights and identify areas that need improvement. Additionally, future work could explore additional features such as expanding the range of integrated APIs, incorporating more interactive elements like live tutorials or discussion forums, and further enhancing the adaptive capabilities of the platform to provide an even more personalised learning experience. Additionally,

In conclusion, *modulo* stands as an innovative solution for self-directed learners, aligning with Sustainable Development Goal (SDG) 4 by promoting inclusive and equitable quality education and lifelong learning opportunities for all. The successful development and deployment of the platform marks a significant milestone, paving the way for ongoing improvements and greater impact in the field of educational technology.

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Conflict of Interest

The authors declare that there is no conflict of interest

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