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Gen AI in Education: How AI helps in Personalized Learning

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Abstract

The rapid development of e-learning materials on sites like YouTube has provided rich prospects for people-focused learning opportunities. Yet students usually struggle with effective searching for and choosing valuable material that aligns with individual goals and preferred learning styles. The current work offers a Personalized AI Course Generator based on the YouTube Data API, and is designed to automatically create peoplefocused and organized learning pathways. By combining user profiling and advanced recommendation algorithms, the tool analyzes metadata in videos, subtitles, and viewer information to identify high-quality study content. The generator dynamically responds to user progress, preferences, and performance metrics in real-time, providing a scalable and accessible alternative to conventional course development. Systematic testing shows enhanced learner engagement and satisfaction, indicating that AI-driven content personalization can efficiently augment self-directed learning.

keyword - Personalized learning, artificial intelligence, course generator, YouTube API, educational technology, recommendation system, adaptive learning.

1. INTRODUCTION

As digital platforms become progressively vital to education, students are gradually accessing video content to learn new information and abilities. YouTube has specially become a popular source for teaching content across numerous industries. Nevertheless, despite the huge diversity of accessible information, many users have challenges in defining, organizing, and sticking to a cohesive learning trajectory. Issues such as a lack of organization, fluctuating quality, and insufficient student customization lead to a disconnected educational experience. To overcome these difficulties, our research offers an AI-driven course production system that leverages publicly accessible video material to produce structured, tailored learning modules. The system leverages the YouTube Data API to obtain instructional videos relevant to specified themes and utilizes the Gemini API to evaluate associated transcripts and information. By evaluating user inputs—such as topic interests and existing knowledge—the system autonomously generates structured course frameworks augmented with AI-generated summaries and formative assessments. By merging content retrieval with generative intelligence, the system intends to deliver scalable and adaptable educational solutions. This methodology tries to link the distance between unstructured digital information and tailored learning requirements, giving an alternative to typical manual course design approaches. The outcome is a dynamic platform designed to promote efficient, learner-focused instruction through automation and instant feedback.

2 LITERATURE REVIEW

2.1 The Need for Automated Course Generation

Innovations in Artificial Intelligence (AI) are having a significant impact on the evolution of instructional content production. Conventional methods of creating educational programs are usually thought of as labour-intensive, timeconsuming, and requiring a great deal of specialised knowledge and human labour [1]. This presents problems for educators who must provide relevant and thorough resources as well as students looking for personalised and engaging learning experiences [8]. In order to address these issues, researchers and developers are looking into how AI, specifically generative AI and the incorporation of outside resources through APIs, can improve and automate the course development process [2], [3]. Artificial intelligence (AI) is being used to create quizzes and other supplemental learning materials [6].

2.2 Using Generative AI to Create Educational Content

Using large language models (LLMs) and natural language generation (NLG) to create educational content is a crucial field of research [4], [5]. Research has demonstrated that models such as ChatGPT and GPT models are capable of producing a wide range of educational materials [2]. For example, a study effectively used ChatGPT to create a thorough, all-inclusive course on multimedia databases [3]. Iterative prompting for translation, content extension, real-world examples, assignments, extra resources, and formatting are all part of this process, which quickly produces an 87-page course [3]. Experts assessed the produced material's quality and accuracy, finding it to be highly original with low similarity rates [3]. This highlights how generative AI holds promise for effective and scalable course development [2], [3]. In addition to full courses, AI has been used to create supplemental learning materials like Reflection Quizzes and Overviews, which provide a synopsis of learning paths [6]. In contrast to standard text extraction techniques, research has looked at using GPT-based models, particularly a GPT-2 based Definition Generator, to generate definitions that can serve as the basis for questions [7]. This approach offers a unique way to generate questions [7].

2.3 Including External APIs and Multimedia

The use of multimedia tools is a key component of modern online education [9]. By providing visual aids and enhancing written content, incorporating external video content—like YouTube lessons—is thought to be a way to improve learning [9]. Systems that use APIs, such as the YouTube Data API, to dynamically incorporate relevant videos into course frameworks are currently under development [10], [11]. The "modulo" tool, which is referred to as an AI Course Generator, specifically aims to combine carefully selected YouTube lessons and related materials into customised learning programs that are produced by AI [3]. Usually based on their transcription, this application uses the YouTube API to choose relevant videos for every lesson [11]. Similar to this, a special technique makes use of the YouTube Data API v3 to gather pertinent video URLs that correspond to every chapter and subtopic, obtain video transcripts, and embed the videos [11]. Additionally, the Pexels API for course images was integrated into the "modulo" platform [3].

2.4 AI-Based Systems Integrating APIs and Generative AI to Generate Courses

Using video content, generative AI could create integrated learning experiences [10]. Each lesson's video transcription is obtained by the OpenAI API in the "modulo" platform, which then uses the video content to create summaries and quiz questions and answers [3]. Additionally, the new approach uses the AI model—specifically, GPT 4o mini/micro—to create concept-check tests and video summaries using the gathered YouTube video transcripts [3]. The challenge of creating interactive tests and summaries by hand is addressed by this automation of supplemental material, which is directly generated from the integrated video resources [6]. In educational technology, automatic question generation—including neural network-based and transformer language model-based systems—is a crucial area of research [6]. The aforementioned new system and the "modulo" platform are examples of AI-based course creation systems that incorporate generative AI with external APIs [3]. These platforms aim to address the shortcomings of conventional methods, including limited flexibility, narrow topic coverage, and the absence of interactive test or YouTube video integration [1], [9]. They dynamically create complex course structures by evaluating user input and applying generative AI models (such as OpenAI's GPT 4o mini/micro) [3]. In order to provide more individualized, comprehensive, and interactive learning experiences, they then enhance these structures by adding relevant YouTube videos and creating tests and summaries based on the video content [3], [10]. These systems use prompt engineering techniques to guide the AI in tasks like creating multiple-choice tests, YouTube search queries, and course outlines [3]. The novel approach particularly emphasizes using OpenAI's GPT 4o mini/micro models for these tasks in conjunction with quick engineering [3]. To improve the generated content, user input tools are being researched [12].

2.5 The Components and Capabilities

These systems primary functions typically include the following steps: processing user input (such as keywords or a desired topic); using generative AI to create a structured study plan (modules, lessons, chapters, and subtopics); retrieving related YouTube videos based on topics or AI-generated search queries; retrieving video transcripts; using generative AI to analyze transcripts and produce content such as quizzes and summaries; and displaying to the user the entire course structure with integrated content [3], [10]. To improve visual appeal, the "modulo" platform also makes use of other APIs, such as Pexels for course photos [3]. Finding key terms, creating definitions (a novel technique described in Source 1 using GPT-2), and transforming these into question formats, like multiple-choice questions (MCQs), are common steps in the creation of quizzes [7]. Various methods, frequently based on neighbourhood construction of tokens, for developing quiz alternatives or distractions are also investigated [7].

2.6 Challenges and Limitations

However, there are challenges in integrating AI into the creation of educational materials [2]. Reducing possible algorithmic biases and ensuring content originality and accuracy raise concerns [2], [5]. The need for human oversight and validation of AI-generated data is emphasised by the sources [2]. There are significant problems with AI producing false or deceptive content and striking a balance between utilising AI's capabilities and maintaining academic integrity [2]. AI may still lack the rich contextual knowledge and inventiveness of human teachers, even though it is capable of producing thorough and imaginative information [2], [5]. When relevant content is removed, the rate of useful material (false negatives) may decrease if strict quality control methods are used for produced content, such as establishing high acceptance levels based on semantic similarity [7]. For example, one system's high criteria meant that only about 22.2% of the definitions that were created were accepted on the test dataset [7]. Additional limitations exist in areas such as identifying the most pertinent "Main Theme" for a learning segment or developing a wider variety of question types (such as "Why?" and "How?" enquiries) [6]. Although conducting thorough testing with a variety of user groups continues to present challenges, evaluating these systems, for example, through user acceptability testing (UAT), is essential [12].

S.No.	Author and Year / Title	Key Focus	AI Methodology	System Description	Key Findings	Remarks
1	Smirna Martin, Dr. A. Sumithra / Personalize d AI Driven Roadmap Generation	Individual goals, skill levels, timelines, user prompts, experience levels	Gemini AI model, machine learning algorithms, Generative AI, Natural Language Processing (NLP), web scraping for content updates.	A system to analyze individual inputs and generate customized roadmaps with step-bystep guides, practice questions, interview tips, and curated resource links. Includes skill gap analysis and progress tracking.	Creates tailored step-by-step guides and comprehensive, highly customized preparation processes. Combines education and career planning. Addresses confusion of selfplanning by generating detailed plans.	Focuses on generating roadmaps rather than full course content, but elements are highly relevant. Ensures roadmap is aligned with upto-date informatio n and industry trends.
2	Syllabus PDFs uploaded by users, desired goals.	Machine learning algorithms to parse and analyze syllabus content.	An AI powered study planner that creates personalized study schedules from syllabus PDFs. Features progress tracking, reminders, and suggestions. Built with React frontend and Spring Boot backend.	Assists users in creating personalized study schedules, highlights important topics, provides timely notifications, and allows easy modification. Aims to optimize study routines and boost productivity and academic success.	Addresses challenges like selecting noncorrespondi ng courses and imbalanced credit hours in manual planning. Potential to revolutionize how students manage academic schedules with continued AI and PDF parsing improvements.	Addresses challenges like selecting noncorrespon ding courses and imbalance d credit hours in manual planning. Potential to revolutionize how students manage academic schedules with continued AI and PDF parsingimprovem ents.

3	Atras et al., 2024 / Artificial Intelligence Driven Course Generation: A Case Study Using ChatGPT	Using ChatGPT for creating educational content, specifically a Multimedia Databases course.	ChatGPT (Generative AI) for content generation, translation, expansion, practical examples, assignments, and LaTeX formatting.	Case study on using ChatGPT to generate a full university course.	Course content generated in less than one day with high originality (low similarity rates). Significant time efficiency, comprehensive content coverage, and flexibility.	Highlights AI's transformative potential while noting challenges like data privacy, technology dependenc e, content accuracy, and algorithmi c biases.
4	Amal, S. F., Saiid, I. A., & Mansor, H. (2024) / An Empirical Study for the Dynamic and Personalise d Learning Experience of the AI Course Generator [1]	Chosen subject, user progress.	Artificial intelligence, external APIs, adaptive quizzes.	"modulo" - a platform to automate creation of personalized and structured learning paths. Integrates YouTube tutorials and supplemental materials. React/Next.js frontend, Supabase/Pris ma backend.	Empowers diverse user groups by enhancing education accessibility. Provides a dynamic and personalized learning experience. Aims to make a meaningful impact on self-directed learning.	Addresses limitations of traditional course creation methods requiring significant human input.

5	Scientific Research Publishing (Authors not specified in snippet), 2024 / Investigatin g How Generative AI Can Create Personalize d Learning Materials Tailored to Individual Student Needs	Student data (learning style, performanc e reviews, engagement level), learning objectives for an OOP course.	Generative AI, OpenAI API integrated with LMS.	Comparison of AIgenerated learning material with traditional material for an ObjectOriented Programming (OOP) course.	Generative AI can create customized learning materials according to individual student's needs and level. Automatic question generation (AQG) for customized tests and quizzes.	Potential for bad/inaccu rate content, data privacy/se curity concerns. Need for content to be relevant, accurate, and tailored to the curriculum .
6	MDPI (Authors not specified in snippet), 2023 / Adaptive Learning Using Artificial Intelligence in e-Learning: A Literature Review	Learner performanc e, knowledge gaps, interests, needs, skills.	AI/ML algorithms for adaptive learning systems (ALSs).	Personalized learning platforms (Adaptive Learning Systems - ALSs).	AI/ML instrumental in personalizin g learning. Optimizes learning paths, enhances engagement, improves academic performance , can increase test scores. Offers realtime feedback and enhanced engagement.	Discusses general benefits of AI/ML in adaptive elearning rather than a specific generator system.

In summary, the literature shows a distinct trend towards the automation and improvement of the production of educational courses and content through the use of AI, specifically generative AI models and external APIs like the YouTube API. This is demonstrated by systems such as "modulo" and the new system under discussion, which integrate multimedia content, create supplemental materials and assessments straight from the content, and dynamically generate course structures. Although these methods demonstrate encouraging outcomes in producing high-quality content quickly, more research and development is required to fully address issues with bias, accuracy, and the required human oversight to guarantee the ethical and successful integration of these technologies in education. Future research might look into improving adaptive capabilities, adding more interactive components, and growing integrated APIs.

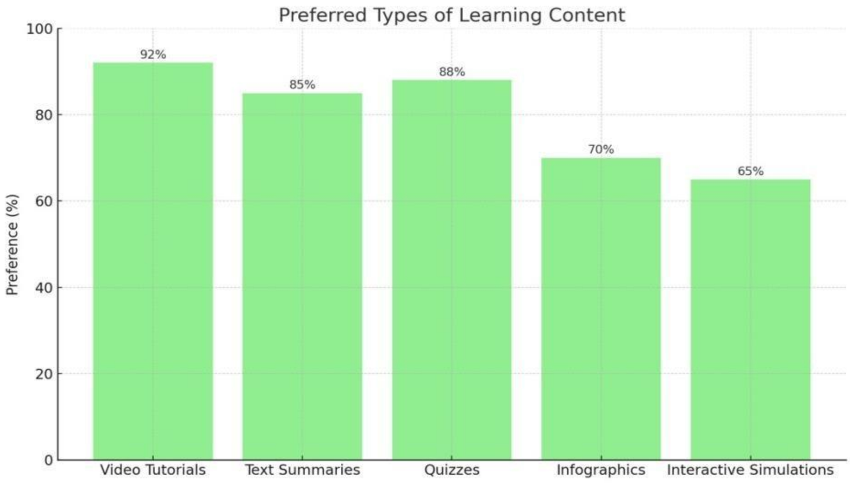


Fig. 1 illustrates the growing preference for video-based learning content over time [9].

3 METHODOLOGIES

To design and implement the Personalized AI Course Generator, we adopted an Iterative Waterfall approach, blending structured development phases with feedback-driven iterations. This allowed us to maintain clear system objectives while staying adaptable to emerging insights and technical challenges throughout the development lifecycle.

3.1 System Architecture:

The system architecture follows a microservices-based model, ensuring scalability and modularity. The frontend is developed using React and Next.js for responsive and fast-loading interfaces. The backend is powered by Supa base, serving as a real-time database and API platform, while Prisma is used as the ORM for seamless database interactions. Next AUTH provides secure user authentication, and Stripe is integrated for future payment or premium content access.

3.2 Data Collection and Processing:

The core data source is the YouTube Data API. Upon receiving a topic from the user, the system queries the API to fetch a set of educational videos. Each video's title, description, view count, like ratio, and closed captions (if available) are extracted. Natural Language Processing is then used to analyses the transcripts and metadata to determine topic relevance, difficulty level, and overall content quality.

3.3 Personalized Learning Path Generation

Once relevant videos are selected, the system organizes them into a sequence based on complexity and learning dependencies. The user is asked to complete a short pre-assessment quiz to help determine their current knowledge level. Based on this input and ongoing interactions, the learning path adjusts dynamically. Videos are grouped into modules, and quizzes are interspersed between modules to reinforce retention and gauge progress**.**

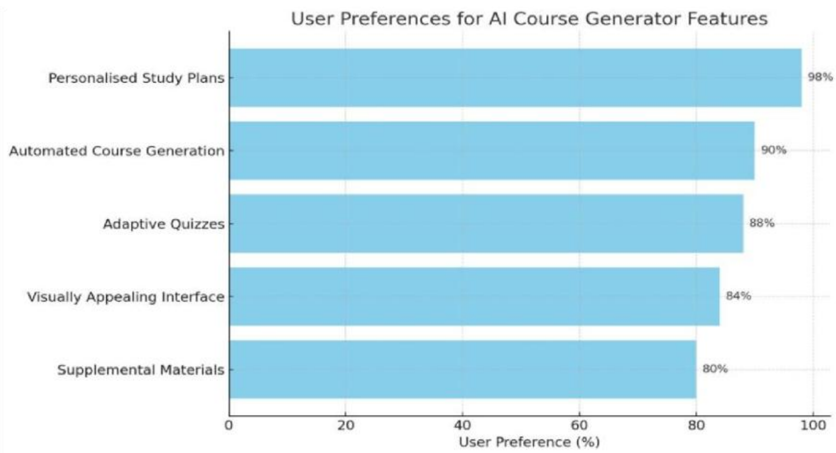


fig 2. User Preferences for AI course generator features

3.4 Feedback and Adaptation

The **fig 2** includes lightweight feedback mechanisms such as thumbs up/down, quiz scores, and time spent per module. These inputs feed into the user model and allow the recommendation engine to fine-tune the content stream. Learners who struggle in a module may be offered remedial content or alternative explanations, while advanced users can skip or fast-track.

3.5 Evaluation Metrics

The system's effectiveness is evaluated based on several metrics: user engagement (average session duration, return rate), content relevance (based on user feedback), learning gain (quiz performance), and user satisfaction (post-course surveys). A/B testing is also used to compare adaptive vs. non-adaptive course flows. This methodology balances automation with personalization and leverages real-time content, creating a flexible learning platform that evolves with the learner's needs and preferences.

4 RESULT AND DISCUSSION

The development and implementation of the AI Course Generator platform, *modulo*, yielded promising results in providing a personalized and efficient self-directed learning experience. The system was evaluated through a User Acceptance Testing (UAT) session involving three students from the Department of Computer Science. All key functionalities—including course generation, content integration, user navigation, and adaptive quizzes performed as intended, meeting the expected criteria defined during the test plan.

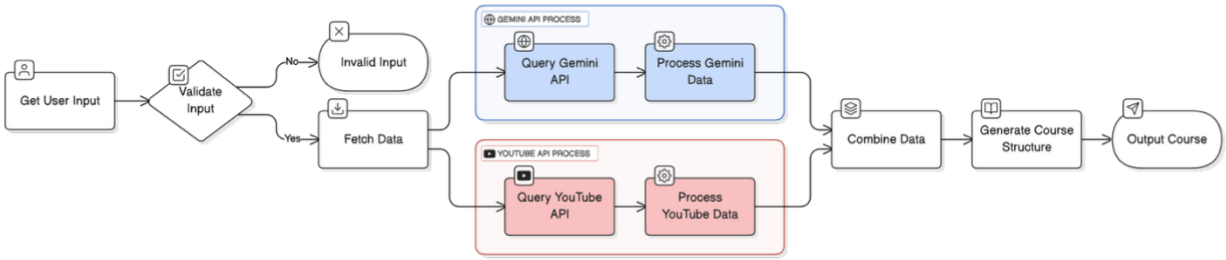


Fig 3. Data Flow

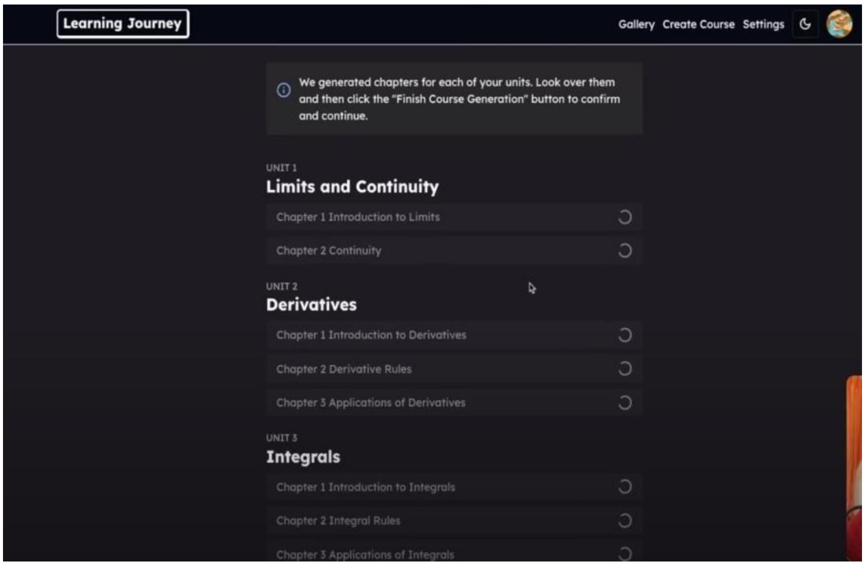
Fig 3. Shows the system architecture and data flow for our AI-based course generator, Students enter the topic or subject area they want to study at the start of the process. After that, the input is put through a validation process to make sure its content and format are suitable for additional processing. Valid inputs move on to the data fetching step, while invalid inputs are marked and rejected.

Two parallel API processes are started in the following phase:

YouTube API Process: To obtain pertinent instructional videos, the system uses the supplied input to query the YouTube Data API. The metadata that has been retrieved, including titles, descriptions, and captions, is subsequently processed to assess the content's quality, difficulty, and relevance. Gemini API Process: Depending on the input topic, the Gemini API is used to simultaneously analyse and produce natural language content. These could be summaries, justifications, or evaluation questions taken from the topic description or video transcripts. Following processing, both sets of data are sent to the Data Combination module, which combines the data from the two sources to create a single, cohesive dataset. The Course Generation Engine then uses this combined content to arrange it into a structured learning path. ll things considered, this architecture facilitates the creation of an intelligent learning platform that can use openly accessible digital content enhanced with AI-driven structure and interactivity to deliver personalised, self-paced education. The platform has effectively produced structured and customized courses based on user inputs, exhibiting a high degree of functional accuracy. The system provided logical and pedagogically sound learning paths by combining the YouTube API for choosing carefully chosen video tutorials and the OpenAI API for creating study plans. It also successfully produced tests that matched every lesson, improving student engagement and memory. Together, these features offered a smooth learning process that adjusted to the user's comprehension and speed. During testing, most user feedback was positive. The user-friendly interface and the pertinence of the produced educational material were consistently praised by the participants. Particularly well-liked features were the dashboard's well-organized layout and adaptive quiz system. This response suggests that the instructional flow and design decisions were well received by the target audience, providing convenience and clarity throughout the learning process. From a technical standpoint, the system demonstrated stability and dependability. Even with several components running at once, the backend, which was created with Supabase and Prisma, maintained steady performance. Next Auth was used to ensure secure user authentication, and Stripe integration made subscription management easier. Together, these components produced a reliable and high-caliber infrastructure. Notwithstanding these achievements, a number of drawbacks surfaced that should be addressed in subsequent iterations. The small testing group—just three users took part in the assessment—is one of the main issues. This small sample size limits how broadly the results can be applied and raises concerns about how well the platform works with a range of user demographics, learning preferences, and subject areas. To properly evaluate scalability and long-term usability, more extensive testing is required. The development team added a "Forgot Password" feature and the ability to add more modules after the initial course generation in response to user feedback. These modifications highlight the platform's dedication to ongoing development by demonstrating its flexibility and responsiveness to changing user needs. Finally, there is a noteworthy potential impact of the platform on education as a whole. It fits in nicely with SDG 4 (Quality Education) objectives by fusing responsive assessment tools, AI-driven course design, and carefully chosen multimedia materials. It has the potential to significantly contribute to more accessible and equitable lifelong learning opportunities globally with the right outreach and scaling.

5. CONCLUSIONS

The AI Course Generator platform, modulo, marks a transformative step in educational technology by addressing the growing need for personalized, self-directed learning. By integrating AI algorithms, curated video content, and adaptive assessments, the system successfully automates the generation of structured and learner-centric study paths. Its microservices-based architecture, user-driven design, and incorporation of APIs like OpenAI, YouTube, and Pexels ensure scalability, interactivity, and rich educational experiences. While the current testing involved a limited user group, initial feedback confirms the platform's usability and impact. Future improvements will benefit from broader testing, expanded features, and deeper personalization to further align with Sustainable Development Goal 4 — ensuring inclusive and quality education for all.



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