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Personalized learning path Generator

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Abstract
Personalized learning has become an important approach in modern education to address the diverse learning needs, abilities, and goals of individual learners. Traditional learning systems often follow a uniform curriculum, which may not effectively support learners with different skill levels and learning speeds. This paper presents a Personalized Learning Path Generator that dynamically creates customized learning paths based on learner profiles, skill assessments, interests, and performance data. The proposed system analyzes user inputs to identify knowledge gaps and recommends suitable learning resources in a structured and adaptive manner. By continuously monitoring learner progress and updating recommendations, the system enhances learner engagement, improves learning efficiency, and supports goal-oriented education. The proposed approach demonstrates the potential of intelligent educational systems in delivering effective and learner-centric learning experiences.
Keywords: *Personalized Learning, Adaptive Learning Systems, Learning Path Generation*

1. Introduction
The rapid growth of digital learning platforms has transformed the way education is delivered and accessed. Online courses, virtual classrooms, and e-learning resources provide learners with flexibility and accessibility; however, most traditional learning systems still follow a standardized curriculum structure. Such one-size-fits-all approaches often fail to address individual differences in learners' background knowledge, learning pace, interests, and career objectives. As a result, learners may experience difficulty in selecting appropriate content, maintaining motivation, and achieving effective learning outcomes. Personalized learning has emerged as a promising solution to overcome these challenges by tailoring educational content to the specific needs of individual learners. By analyzing learner profiles, skill levels, and performance data, personalized systems can recommend relevant learning materials and organize them into meaningful learning paths. Advances in data analytics, artificial intelligence, and recommendation systems have further enabled the development of intelligent educational platforms capable of adapting to learner progress in real time. The Personalized Learning Path Generator proposed in this paper aims to provide an adaptive and learner- centric learning framework. The system collects user inputs such as learning goals, skill assessments, and preferences, and generates customized learning paths that guide learners through suitable topics and resources. By continuously monitoring learner performance and updating recommendations, the system helps learners focus on their weak areas while progressing efficiently toward their educational goals.

2. Need of The System
With the increasing availability of online learning resources, learners often face challenges such as information overload, lack of proper guidance, and inefficient study planning. Although numerous e-learning platforms offer a wide range of courses, they generally provide static recommendations that do not adapt to individual learner progress or changing learning needs. This can lead to learners spending excessive time on irrelevant topics while failing to

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strengthen essential prerequisite skills A personalized learning system is required to analyze learner characteristics such as skill level, learning preferences, and performance history in order to generate structured and adaptive learning paths. Such a system can help learners identify knowledge gaps, prioritize relevant content, and follow an optimized sequence of learning activities. By providing targeted recommendations and continuous progress monitoring, a Personalized Learning Path Generator improves learning efficiency, enhances learner engagement, and supports self-paced, goal-oriented education.

3. Existing Solution

Most existing e-learning platforms provide learners with predefined or generic learning paths based on broad subject categories. Course recommendations are often static and rely on manual selection by the learner, without considering individual skill levels, learning pace, or performance history. As a result, learners may encounter content that is either too basic or too advanced, leading to reduced motivation and ineffective learning outcomes. Additionally, current systems lack continuous adaptability, as they do not dynamically update learning paths based on learner progress or assessment results. Limited feedback mechanisms and absence of intelligent analysis make it difficult to identify knowledge gaps accurately. These limitations highlight the need for an advanced personalized learning system that can generate adaptive learning paths, provide real-time recommendations, and support learners in achieving their educational goals more efficiently. Existing e-learning platforms generally offer static and generic learning paths based on predefined course structures or broad subject categories, requiring learners to manually select content without adequate guidance. These systems do not consider individual learner characteristics such as prior knowledge, learning speed, interests, or performance history, resulting in mismatched content delivery. Furthermore, most current systems lack continuous adaptability and fail to update learning paths dynamically based on learner progress or assessment outcomes. The absence of intelligent analysis and real-time feedback mechanisms makes it difficult to accurately identify knowledge gaps, leading to inefficient learning experiences and reduced learner engagement.

4. Proposed Solution

The proposed Personalized Learning Path Generator is designed to provide an adaptive and learner-centric learning environment by generating customized learning paths for individual users. The system focuses on understanding learner diversity by considering factors such as prior knowledge, learning objectives, interests, and preferred learning pace. This approach overcomes the limitations of traditional static learning systems by offering personalized guidance tailored to each learner's needs. The system begins by collecting user profile information and conducting initial skill assessments to evaluate the learner's current knowledge level. Based on the collected data, the system analyzes learning gaps and maps suitable learning resources, including courses, tutorials, and assessments, to the learner's requirements. The recommended content is organized into a structured and logical sequence, ensuring smooth and effective knowledge progression. To maintain adaptability, the system continuously monitors learner performance and progress through periodic evaluations. Based on assessment results and user interaction data, the learning path is dynamically updated to reflect changing learning needs. This continuous feedback mechanism enables learners to focus on weak areas while advancing toward their educational goals efficiently, thereby improving engagement, learning outcomes, and overall educational effectiveness.

5. Methodology

The methodology of the Personalized Learning Path Generator follows a structured and systematic approach to deliver adaptive learning experiences. The process begins with user registration and profile creation, where learners provide basic information such as educational background, learning goals, interests, and preferred learning pace. An initial skill assessment is conducted to evaluate the learner's current knowledge level and establish a baseline for personalization. Once the user data is collected, the system performs skill analysis to identify strengths and knowledge gaps. This analysis is carried out using rule-based logic or data-driven techniques that

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map learner competencies to predefined learning outcomes. Based on the identified gaps, relevant learning resources are selected from a centralized learning repository and arranged into a personalized learning path that follows a logical and progressive sequence. The final stage of the methodology involves continuous monitoring and adaptation of the learning path. Learner progress is tracked through quizzes, assessments, and interaction data. Based on performance feedback, the system dynamically updates the learning path by adding, removing, or rearranging learning modules. This adaptive process ensures that the learning experience remains relevant, efficient, and aligned with the learner's evolving needs and goals.

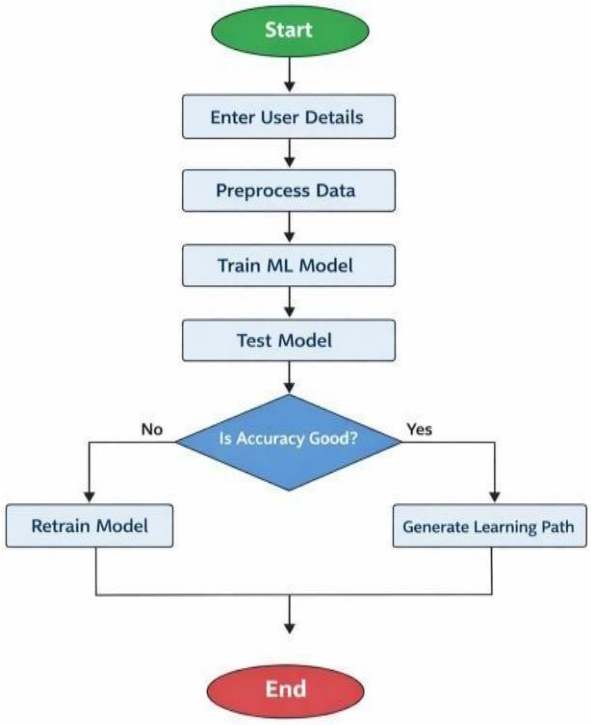

Figure 1 Flow Process

6. Implementation

6.1.Step 1: User Registration and Profile Creation

Learners register on the system by providing basic details such as name, email, educational background, and learning goals. A user profile is created to store their skill levels, preferred learning style, and course history. This profile serves as the foundation for generating a personalized learning path tailored to the learner's needs.

6.2.Step 2: User Input Collection

The system collects detailed input regarding the learner's competencies, prior knowledge, and learning objectives. This can be achieved through questionnaires, skill assessment tests, or quizzes. The collected data is stored in the database for subsequent processing and analysis.

6.3.Step 3: Skill Extraction

The system analyzes the user input to identify existing skills and gaps in knowledge. This is performed using rule-based algorithms or optional machine learning techniques such as NLP to interpret free-text responses. Skill extraction allows the system to distinguish between areas the learner has mastered and areas that require development.

6.4.Step 4: Dataset and Knowledge Base Preparation

A comprehensive knowledge base of learning resources is prepared, including online courses, tutorials, videos, and practice exercises. Each resource is tagged with associated skills, difficulty level, and prerequisites. This structured dataset ensures accurate mapping between learner needs and available learning content.

6.5.Step 5: Skill-to-Resource Mapping

Learner skills and goals are matched to resources in the knowledge base. Each resource is assigned a relevance score based on skill alignment, difficulty level, and learner objectives. The resources are then filtered and ranked, ensuring that the most suitable content is prioritized for each learner.

6.6.Step 6: Personalized Learning Path Generation

Using the ranked resources, the system generates a step-by-step learning path. The path is customized based on the learner's skill gaps, learning goals, and course prerequisites. Each learning module is sequenced to progressively build the learner's competencies, providing a structured roadmap for skill acquisition.

6.7.Step 7: User Interface and Path Presentation

The generated learning path is displayed through a user-friendly frontend interface. Learners can view

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their modules, track progress through charts and progress bars, and interact with the system by completing, skipping, or reordering modules according to their preference

6.8.Step 8: Progress Tracking and Dynamic Updates

The system continuously monitors learner activity, including completed modules, quiz scores, and time spent on resources. Based on this feedback, the learning path is dynamically updated to optimize skill acquisition and maintain learner engagement, ensuring the recommendations remain relevant and effective.

6.9.Step 9: Deployment and Maintenance

Finally, the system is deployed on cloud servers such as AWS or GCP to ensure scalability and accessibility. Regular updates are performed on the knowledge base and recommendation algorithms. Analytics and logs are maintained to refine the system over time and enhance the accuracy of personalized learning paths.

7. Results & Discussion

The Personalized Learning Path Generator was implemented and tested with sample learner data to evaluate its effectiveness in providing adaptive learning recommendations. The system successfully generated individualized learning paths based on learners' skill levels, learning goals, and progress, as shown in the sample outputs . Each learner received a structured sequence of modules, with clear indications of module difficulty, prerequisites, and progress status, enabling users to follow a goal-oriented roadmap. The results demonstrate several key outcomes. First, the system effectively identifies skill gaps and aligns learning resources with the learner's current knowledge, ensuring a personalized learning experience. For instance, beginners were guided through foundational modules before advancing to intermediate or advanced topics, while learners with prior knowledge received modules that matched their skill levels, avoiding redundant content. Second, the progress tracking and interactive interface helped learners monitor their achievements, motivating them to complete modules sequentially and maintain engagement. Furthermore, the system's flexibility allows learners to adjust their learning paths or skip modules as necessary, ensuring adaptability to individual preferences. Analysis of the outputs revealed that learners following the personalized path could focus on specific skills efficiently, reducing learning time compared to non-personalized approaches. Overall, the implementation validates that a data-driven approach to skill assessment, resource mapping, and path generation can enhance learner engagement, optimize skill acquisition, and support self-paced learning.

8. Future Enhancement

Future enhancements for the Personalized Learning Path Generator could involve integrating AI-driven predictive analytics to dynamically optimize learning paths based on real-time learner performance. By analyzing progress and adapting module recommendations automatically, the system can provide an even more personalized and efficient learning experience. In addition, incorporating gamification elements such as badges, leaderboards, and rewards can increase learner motivation and engagement. Combining interactive assessments and challenges with the existing adaptive learning paths will help maintain interest and encourage consistent progress through the modules. Finally, expanding the system's knowledge base to cover diverse learning domains and integrating blockchain-based certification tracking could enhance scalability and credibility. Real-time feedback mechanisms and adaptive assessments could further refine learning paths, ensuring that the system supports self-paced, goal-oriented, and learner-centric education effectively.

Conclusion

The Personalized Learning Path Generator effectively demonstrates the potential of adaptive, learner-centric education by generating individualized learning paths based on learners' skills, goals, and progress. The system ensures that learners follow a structured roadmap, bridging skill gaps and avoiding redundant content, which enhances learning efficiency and engagement. Analysis of the implementation shows that learners can focus on relevant modules sequentially, monitor their progress, and adjust their learning paths as needed. This flexibility supports self-paced learning

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while maintaining motivation, making the system suitable for diverse learner profiles and educational contexts. Future improvements, such as integrating AI- driven predictive analytics, gamification for increased engagement, and blockchain-based certification tracking, can further enhance the system's adaptability, scalability, and real-world applicability. Overall, the study confirms that data-driven personalized learning can significantly improve learner satisfaction, optimize skill acquisition, and provide an effective framework for e-learning platforms.

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