



# AI-BASED PERSONALIZED LEARNING SYSTEM WITH DYNAMIC FEEDBACK AND CRITICAL THINKING FEATURE

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**Abstract:** The traditional e-learning system allows users to learn new things easily but the problem arises because it fails to consider learning ability of individuals. Some learners have understood the concepts in less time but some takes more time and it does not give importance for increasing critical thinking and gives only limited access to users. This limitation has become the reason to implement new learning system by using artificial intelligence. The main advantage of this work is that it allows learner to give feedback for the quizzes generated by it. Some learners may find the questions easy while others may find them difficult based on this feedback the system automatically adjusts upcoming concepts and question difficulty. It also increases critical thinking of user by analyzing the things in different way rather than just giving importance only for memorizing the things. The system also includes a progress bar in which user can easily see the number of courses they are learning and percentage of each course.

**Index Terms** - Feedback-Based Learning, Artificial Intelligence, Critical Thinking, Personalized Learning, e-learning System

## I. INTRODUCTION

The advancement in the field of Artificial Intelligence has made the significant changes in field of education system. Traditional learning system uses a common learning approach for all users approach which it unable to analyze the students with different learning speed, understanding levels, academic goals and does not gave importance for increasing critical thinking level of learners. So, the learner has to face these problems and give limited access to the resources. By this problem arise because user are unable to understand the concepts. Many learners require additional guidance and enough time to understand new concepts effectively. To solve this issue the proposed system uses artificial intelligence to develop a smart personalized learning platform. The system analyzes the learners behaviour, understanding capacity, and critical thinking skills to provide suitable learning support. It helps users to study concepts according to their level of knowledge, such as beginner, intermediate, or expert. Based on the learner's current understanding, the platform generates a structured roadmap that helps them plan their learning process over a selected duration of weeks or months. The system provides learning materials, quizzes and daily tasks based on user topic selection. Resources help learners to improve their knowledge and track their progress efficiently. learners are able to access content that relevant to their current proficiency level of knowledge which provides a customized learning experience. The system includes automated assessment modules and a feedback feature. Responses provided by learners are taken as a input to change and update the learning content whenever required and it also include the details about number of courses in which user enrolled, completion status and number of hours spent on the topic.

## II. LITERATURE REVIEW

John F. Pane et al. in [1] analysed the significance of personalized learning approaches in educational institutions. Their research represented that personalized learning helps students to learn the content in their own speed and according to their individual abilities. The work shows that students who use learning systems perform well academically and showed increased motivation compared to those using traditional learning methods. Beverly Park Woolf in [2] introduced the Intelligent Tutoring Systems (ITS) which use artificial intelligence techniques to provide personalized guidance to students. Their study explained how these systems check progress of student and identify knowledge gaps and give personalized feedback during learning sessions. The research gives important impact that AI-based tutoring systems helps in improving performance by giving support to students for complex topics step by step Peter Brusilovsky in [3] conducted early research on adaptive educational systems and personalized learning technologies. Their work focused on how computer-based learning platforms can adapt study materials according to student preferences, learning pace and prior knowledge. The study demonstrated that adaptive learning systems significantly improve learner engagement because they provide content tailored to individual needs.. D'Mello et al. in [4] investigated how intelligent learning environments can enhance student engagement. Their work focused on a system that checks student emotions and learning behaviours during online learning sessions. By analyzing learner experience and engagement patterns AI systems can adjust teaching resources and provide appropriate feedback to support the learning process. Holmes et al. in [5] explain artificial intelligence impact in education and highlighted its impact in transforming traditional teaching methods. Their work explains machine learning algorithms can analyze large number of learner data to identify patterns in student performance. This information can then be used to create adaptive learning systems that deliver personalized content to students.

Chung Ming Chen in [6] explored adaptive learning platforms that adjust educational materials based on the learner's current knowledge level and demonstrated that this platforms help learners understand concepts more effectively because the system provides appropriate learning resources depending on their performance. Author in [7] explains about the effect of AI-based tutoring systems on performance of student learning. Their work highlighted that continuous assessment and personalized feedback helps students to correct their mistakes quickly and improve their level of understanding in complex subjects. Rose Luckin et al. in [8] discussed how artificial intelligence can integrated in learning and teaching processes. Their work explains that AI technologies can assist both teachers and learners by recommending relevant learning materials, monitoring student improvement and providing intelligent support systems in order to increase the knowledge in difficult concepts by providing more importance to that rather than simple topics. George Siemens in [9] introduced the concept of learning analytics which involves collecting and analyzing learner data to improve educational systems. Their work demonstrated that analyzing student interactions with digital learning platforms helps educators understand how students learn and how the challenges they face during the learning process. They analyzed this problem by considering students and find solution for it. Authors in [10] conducted studies on step-based intelligent tutoring systems. Their work found that AI-based tutoring systems can achieve learning gains comparable to human tutors, particularly when they provide step-by-step guidance and personalized feedback. Learners can easily upgrade themselves by learning concepts step by step as it helps in improving their knowledge gradually.

Graesser et al. in [11] developed AutoTutor an intelligent tutoring system that uses natural language processing to interact with learners. The system asks questions, analyzes student responses and provides clues to guide learners toward the correct answers. This work demonstrated the effectiveness of conversational AI in education. Kulik et al. in [12] works analysis on the effectiveness of usage of AI in computer-based tutoring systems. Their work concluded that students who used intelligent tutoring systems generally performed better than those using traditional classroom instruction alone. Authors in [13] carried out a systematic review on artificial intelligence applications in higher education. Their work identified several important areas where AI can improve education including personalized learning, automated assessment and intelligent tutoring systems. This explains about all major areas where AI can be most effectively implemented to help the learners. Du Boulay et al. in [14] explains learners thinking and answering techniques used in AI-based educational systems. Their work focused on how AI systems create resources of learners by analyzing their knowledge level, learning preferences and performance data. Baker et al. in [15] explored the role of educational data mining in analyzing student behavior within digital learning environments. Their work showed that analyzing learner interactions helps developers design better adaptive learning systems.

Wang et al. in [16] explains the use of machine learning algorithms to predict student performance. The authors showed that machine learning models can help to find students who are not able to understand the topics, struggling to learn complex topic and need additional support to improve learning outcomes. This helps to overcome these problems by using machine learning approach. Anderson et al. in [17] explains about cognitive tutoring systems designed to enhance problem-solving and reasoning skills and showed that such systems encourage learners to think critically and apply their knowledge to solve complex problems. Hattie et al. in [18] explain about the importance of feedback in the learning process. Their work showed that timely and proper feedback helps learners to understand mistakes, improve their performance and develop in-depth understanding of concepts and improve critical thinking ability. Dede et al. in [19] explains about advancement in field of technology in learning environments that support personalized learning and critical thinking. Their work suggested that interactive digital platforms encourage students to actively participate in learning activities. Authors in [20] works talks about modern AI-driven educational platforms and combining adaptive learning technologies. By using this learner thinking ability and problem-solving approach increase and significantly improve both knowledge acquisition and critical-thinking skills.

### III. PROPOSED SYSTEM

The proposed system Smart AI Platform is designed to provide an intelligent and adaptive learning experience for users. Students can study subjects according to their knowledge base and their preferred pace of learning. The system helps users to advance their knowledge base and cognitive skills through customized content delivery which differs from their established learning patterns. The most important aspect of the is personalized learning. The platform analyzes learner behaviour after user search content and select mode like beginner intermediate or expert by this interaction system understand the learner's capability. The system creates specialized educational materials together with assessment exercises. This helps user receives suitable content according to their own level of learning and with their own learning speed. The system includes a critical element which functions as a mechanism for obtaining user feedback. The users can give their opinions about how difficult they found the content and what they understood. Users can provide feedback on the difficulty and understanding of the content. Based on this feedback, the system updates upcoming learning materials and improves the learning experience. This continuous feedback process helps in achieving better learning and user performs well, the system provides more challenging content and if the learner finds difficulty, the system simplifies the content. This helps learners to understand concepts easily without facing any difficulty.

The system also helps in improving critical thinking skills of learner by providing analytical and problem based questions. These questions help users to think logically, analyze problem pattern and apply concepts instead of just memorizing the content. With learning features, the system provides progress tracking, enable user to see their performance through graphs and completion percentages. This helps learners to monitor their improvement and stay focused. This makes the system more efficient and advanced compared to existing learning platforms.

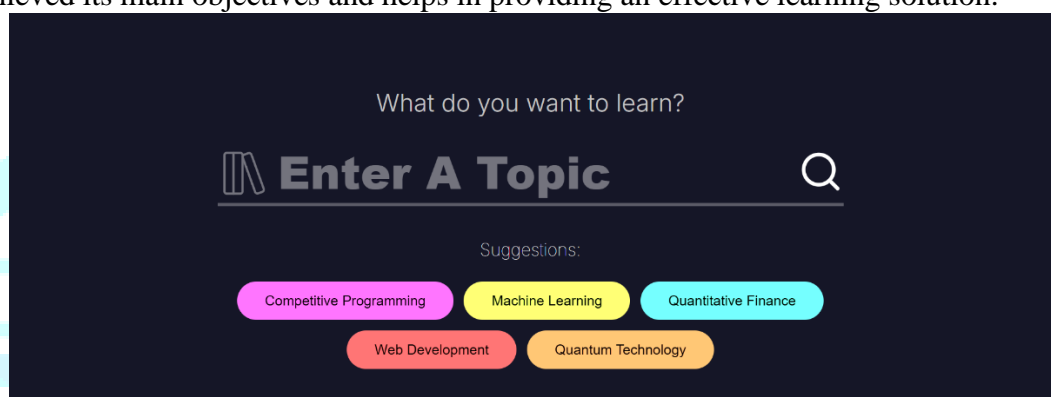
### IV. METHODOLOGY

The methodology adopted in the proposed system focuses on building a web-based AI smart learning environment and critical thinking enhancement. The working of the Smart AI platform starts with user registration and login into the system. The user can utilize the platform with simple interface. After successful login the system enables the user to select the topic and learning level. User log in to the system, it collects important data such as quiz responses, learning speed, and user interaction. This data is stored in the database and used for further analysis. Based on this information the system creates a learner profile which helps in analyzing the user strengths and weaknesses. The proposed system is developed using React for frontend and Python with Flask for backend. Simple, responsive and interactive user interface was developed using React. Flask is lightweight backend framework helps in handling the server side operations and managing the main functionalities of the application like data processing, user authentication and communication between different system modules. The frontend and backend are connected using APIs, which helps in smooth communication and efficient information exchange within the system. Whenever a user performs an action, such as requesting learning content or attempting a quiz, the frontend sends a request to the backend through the API. The backend processes the request and returns the appropriate response to the user. This process ensures real-time interaction and seamless system performance.

By using all of these technologies helps in building an effective and simple learning platform.. The most important factor is that it plays major role in increasing critical thinking skills , understanding ability of learners.

## V. RESULTS AND DISCUSSIONS

The results of the Smart AI Platform shows that system performs efficiently and satisfies the objectives of the project. Developed and tested modules including user authentication, learner profile management, content generation, quiz management, feedback handling and progress monitoring. The platform offers learning materials based learners choice and preferred pace. Users can choose levels such as beginner, intermediate or advanced. The system provides study content and changes the quiz difficulty based on the selected level. The feedback module allows users to share feedback regarding content difficulty and understanding. Based on this feedback, the system automatically adjusts future learning materials and helps in making learning process effective and personalized. This continuous feedback helps in improving system performance. The critical thinking feature helps user to solve analytical and problem based questions and helps users to think logically, apply concepts and improve their reasoning skills instead of depending only on memorization and gradually increase the critical thinking ability of users. The system successfully provides personalized learning, improves user engagement and increases critical thinking skills. The platform achieved its main objectives and helps in providing an effective learning solution.



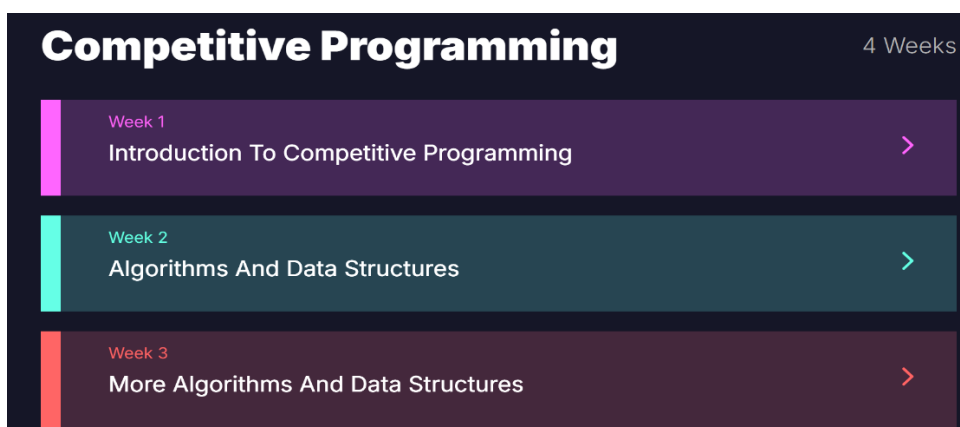
**Figure 1: Search Bar for Topic Selection and Suggestions**

Figure 1 represent about user interface which helps the user to search for the topic in which they have interested to get more information regarding the topic and helps learners to search for it. By default it will show suggestion of some topic below the search bar and user can choose it which will decreases time needed search the topic.



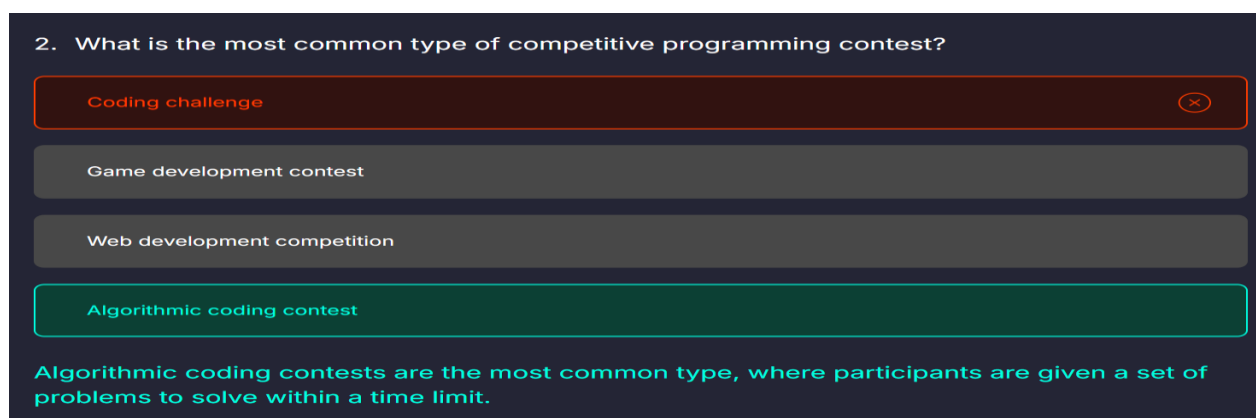
**Figure 2: Personalized Learning Selection**

User after searching the topic the system automatically navigates to personalized learning selection which is represented in Figure 2. It helps the user to select number of weeks they wish to learn about that topic and can easily learn the topic by their current knowledge level on that topic like beginner, intermediate or expert based on that content and quizzes are generated.



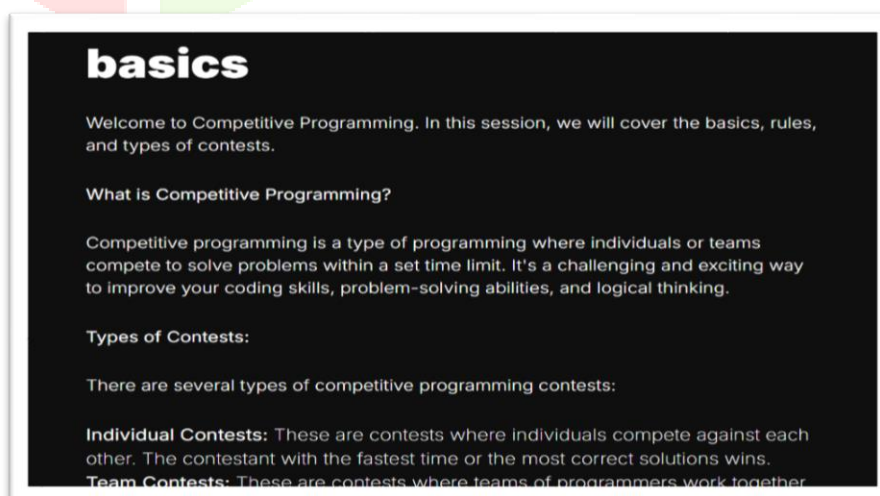
**Figure 3: Roadmap generation**

Figure 3 illustrates the learning roadmap generated by the system. System divides the content and organizes it in weeks according to the user input and give the structured resources to the user. As it helps the user in without facing any difficulty in understanding and learn the topic easily day by day.



**Figure 4: Quiz Interface**

After reading the content generated by the platform, generate questions about the topic with multiple choices as shown in Figure 4. After user selecting the options from the given choices it shows whether the answer is right or wrong and also give reason for the right answer so that user can able to get clear knowledge about that topic. So it helps the user in understand mistake and improve learning.



**Figure 5: Content Generation Page**

Based on user area of interest and learning time system generates the content based on users input. Content will display on the user interface and in the textual format and user can easily understand the content which is represented in Figure 5. The content is generated based on user present knowledge level as they are chosen previously generating the content.

## VI. Conclusion

To overcome the limitation of traditional learning system proposed system was developed. The main goal of the system was to give personalized learning experiences and improve critical thinking skills in learners. By using artificial intelligence technology to analyse user performance and generate customized learning roadmap and content for learners. The adaptive learning mechanism ensured that each learner received content suitable to their level which helped in improving understanding and reducing learning difficulties. The feedback based learning approach plays a important role in improving system performance. By collecting user feedback and updating future content and provide a better and more effective learning experience. Implementation of analytical and problem based questions help in increasing critical thinking skills and this not give more importance to memorizing concept it gives importance to understanding concepts. This makes the system more advanced compared to traditional learning platforms. The proposed work provides a smart, adaptive and easy learning platform for learners. This work can be improved by adding advanced AI features, multilingual support, and real-time learning capabilities in future.

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