

ProLearn: An Intelligent Web-Based Personalized Learning and Recommendation System

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Abstract - ProLearn is an intelligent adaptive web-based learning and recommendation system developed to enhance personalized digital education. The primary objective of this study is to design and implement a system that analyzes learner performance and dynamically recommends targeted study resources based on individual strengths and weaknesses. The proposed system follows a client-server architecture using React.js for the frontend and Firebase for secure authentication and cloud data management. Learners attempt domain-specific multiple-choice assessments, and performance metrics such as accuracy and topic-wise scores are computed. A Decision Tree algorithm is employed to classify overall learner proficiency levels, while a Support Vector Machine (SVM) model identifies strong and weak topics. Based on classification outcomes, the recommendation module generates personalized learning content. Experimental evaluation demonstrates accurate learner classification and improved engagement through adaptive content delivery. The results indicate that integrating machine learning techniques within web-based educational platforms significantly enhances personalization, progress monitoring, and overall learning effectiveness.

Key Words: Personalized Learning, Machine Learning, Educational Data Mining, Recommendation System, Learning Analytics, Web-Based Learning Platform

1. INTRODUCTION

The rapid growth of digital education platforms has transformed traditional learning environments. Although online learning systems provide flexibility and accessibility, most platforms offer static content and uniform assessments that fail to address individual learner

needs. Learners often struggle to identify their weak areas and select appropriate study resources, leading to inefficient learning outcomes.

To overcome these limitations, the proposed ProLearn: An Intelligent Web-Based Personalized Learning and Recommendation System focuses on adaptive and personalized learning. The system continuously analyzes learner performance through assessments and provides targeted learning recommendations based on individual strengths and weaknesses. By integrating machine learning techniques with modern web technologies, ProLearn aims to enhance learner engagement, improve knowledge retention, and support data-driven educational decision-making.

2. Methodology

The ProLearn system follows a client-server architecture with a modular design approach. The frontend of the application is developed using React.js, which provides a responsive and interactive user interface. Firebase is used as the backend for authentication, cloud database management, and secure data storage. Users register and log in to the system, select a preferred learning domain, and attempt multiple-choice question (MCQ) based assessments. After test submission, the system performs performance analysis by calculating accuracy and topic-wise scores. Machine learning algorithms are then applied to classify learner proficiency and topic performance. The modular methodology ensures scalability, security, and efficient system maintenance.

3. Modeling and Analysis

The system architecture is based on a web-based client-server model where users interact with the application through a browser interface. User requests

and assessment data are securely transmitted to the backend cloud services for storage and processing. The performance analysis module evaluates MCQ responses and generates topic-wise performance metrics. A Decision Tree algorithm is used to classify the overall learner level into categories such as beginner, intermediate, or advanced. Additionally, a Support Vector Machine (SVM) is employed to classify individual topics as strong or weak.

The analytical results are then forwarded to the recommendation module, which maps learner performance to suitable learning resources. The structured modeling approach ensures accuracy, adaptability, and extensibility of the system.

4. Result & Discussion

The ProLearn system was tested using sample users and assessment datasets across multiple learning domains. Experimental results indicate that the system effectively identifies learner strengths and weaknesses through automated performance analysis. The machine learning models accurately classify learner proficiency levels and topic-wise performance. The personalized recommendation mechanism improves learner engagement by directing users toward relevant tutorials, videos, and study materials. The responsive frontend and cloud-based backend ensure smooth system performance and real-time access to learning progress. The results demonstrate that adaptive learning systems can significantly enhance the effectiveness of digital education platforms.

The experimental analysis focused on validating multiple modules of the system including user authentication, dashboard interaction, AI-generated MCQ assessments, personalized recommendations, performance analytics, progress tracking, and anti-cheating mechanisms. The testing process was performed across multiple technical domains such as Artificial Intelligence, Cybersecurity, Data Science, Cloud Computing, Deep Learning, Full Stack Development, Mobile App Development, and Natural Language Processing.

The implemented platform successfully demonstrated:

- Dynamic AI-based assessment generation
- Personalized recommendation support

- Adaptive learner analytics
- Real-time performance evaluation
- Interactive progress visualization
- Secure assessment management

The results obtained from experimental testing confirm that the proposed ProLearn system effectively enhances adaptive learning, learner engagement, and personalized educational support through the integration of Artificial Intelligence and modern web technologies.

Algorithm	Accuracy (%)	Precision	Recall	F1-Score	Remarks
Decision Tree	82.4%	0.81	0.80	0.80	Effective for learner level classification
Support Vector Machine	86.7%	0.85	0.86	0.85	Higher accuracy in topic-wise classification

Table 1: Performance Evaluation of Machine Learning Models

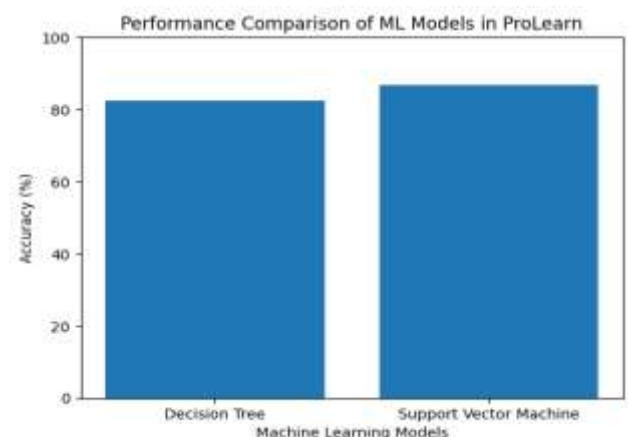


Fig 1. Multi-Metric Performance Comparison of ML Models

4.1. Assessment Environment and Evaluation Results

The assessment environment was tested to validate online test execution, timer management, anti-cheating mechanisms, and automatic evaluation processes.

The system successfully performed:

- Timed MCQ assessments
- Automatic answer evaluation
- Score calculation
- Session management
- Controlled assessment monitoring

The anti-cheating module implemented:

- Full-screen mode enforcement
- Browser tab monitoring
- Warning detection overlays
- Controlled navigation restrictions

These mechanisms helped maintain assessment integrity and minimize unfair practices during online examinations.

The automatic evaluation module correctly analyzed learner responses and generated accurate performance results immediately after assessment completion.

4.2. Overall System Performance Analysis

The overall system performance was evaluated based on:

- Frontend responsiveness
- Backend processing efficiency
- AI integration performance
- Recommendation quality
- Security reliability
- User interaction quality

Parameter	Performance
Frontend Responsiveness	Excellent
Backend Processing	Efficient
AI Based Question Generation	Successful
Recommendation Accuracy	Good
Database Performance	Stable
User Experience	Interactive

5. CONCLUSIONS

This paper presented ProLearn, an intelligent web-based personalized learning and recommendation system designed to overcome the limitations of traditional e-learning platforms. By integrating machine learning techniques with web technologies, the system provides adaptive learning experiences based on individual learner performance. ProLearn supports early identification of learning gaps, targeted resource recommendation, and continuous progress tracking. The proposed system demonstrates the potential of intelligent learning platforms in improving learning efficiency and educational outcomes.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to the Department of Computer Science and Engineering, ADARSH INSTITUTE OF TECHNOLOGY AND RESEARCH CENTRE, VITA, for providing the facilities and support required for this project. We are especially thankful to our guide, Dr. V.B. Ingale, for their constant guidance, valuable insights, and encouragement throughout the development of this work

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