



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 9.935

Volume 15, Issue 5, May 2026

AI-Powered E-Learning System for Personalized Learning and Student Performance Analysis

Priyadarshani Gaikwad, Onkar Jadhav, Shivraj Patil, Sanika Lahigade, Dr. Ashish Patil

U.G. Student, Department of Computer Engineering, JCEP, K.M.Gad, Maharashtra, India

U.G. Student, Department of Computer Engineering, JCEP, K.M.Gad, Maharashtra, India

U.G. Student, Department of Computer Engineering, JCEP, K.M.Gad, Maharashtra, India

U.G. Student, Department of Computer Engineering, JCEP, K.M.Gad, Maharashtra, India

Professor, Department of Computer Engineering JCEP, K.M.Gad, Maharashtra, India

ABSTRACT: The rapid advancement of artificial intelligence has created new opportunities in the field of education, particularly in personalized and adaptive learning systems. This paper presents an AI-based E-learning Application designed to enhance students' learning experience by integrating multiple intelligent models. The system focuses on improving English communication skills along with general knowledge and day-to-day life understanding. It incorporates modules such as grammar correction using a Transformer-based model, vocabulary enhancement through a dictionary-based approach, emotion detection using deep learning techniques, and student performance analysis with adaptive learning using machine learning algorithms. The system analyzes student input and behavior to provide real-time feedback, personalized recommendations, and dynamically adjusted learning difficulty levels. It also includes interactive features such as quizzes and games to improve engagement and learning efficiency. The backend is developed using Python-based machine learning models, while the frontend is implemented as an Android application, ensuring usability and accessibility. The results demonstrate that the system effectively enhances learning outcomes by providing intelligent, adaptive, and user-friendly support, offering a significant improvement over traditional e-learning systems.

KEYWORDS: Artificial Intelligence, E-learning, Adaptive Learning, Emotion Detection, Grammar Correction, Machine Learning

I. INTRODUCTION

The rapid advancement of artificial intelligence (AI) has significantly transformed various sectors, including education. Traditional e-learning systems often provide static and generalized content, lacking personalization and adaptability to individual student needs. This limitation reduces student engagement and learning efficiency, particularly in skill-based domains such as language learning and day-to-day knowledge acquisition.

In recent years, intelligent learning systems have gained attention due to their ability to analyze user behavior and provide customized learning experiences. However, many existing systems still fail to incorporate real-time feedback mechanisms, emotional intelligence, and adaptive content delivery. As a result, students often struggle with improving their grammar, vocabulary, and overall communication skills, while also lacking guidance in practical and real-life knowledge. To address these challenges, this research proposes an AI-based E-learning Application that integrates multiple machine learning models, including emotion detection, grammar correction, vocabulary enhancement, student analysis, and adaptive learning. The system is designed to provide personalized feedback, analyze student performance, and dynamically adjust learning difficulty levels based on user interaction.

The proposed system not only focuses on improving English language skills but also aims to enhance general knowledge and day-to-day life understanding. By combining artificial intelligence with interactive learning modules such as quizzes and games, the system creates an engaging and intelligent learning environment.

Overall, this research contributes to the development of a comprehensive, adaptive, and user-centric e-learning platform that improves learning outcomes, enhances engagement, and supports continuous skill development.

II. LITERATURE SURVEY

With the rapid growth of artificial intelligence in education, numerous research studies have focused on developing intelligent and adaptive learning systems. This section reviews existing work related to e-learning, adaptive learning, emotion recognition, and natural language processing techniques used for educational applications.

Several studies have highlighted the importance of **adaptive learning systems**, which adjust content based on student performance and learning behavior. These systems use machine learning algorithms to personalize the learning experience, resulting in improved engagement and better learning outcomes. However, many traditional adaptive systems rely only on performance data and do not consider emotional or behavioral factors.

Research in **emotion recognition using computer vision techniques**, particularly Convolutional Neural Networks (CNN), has shown promising results in identifying student emotions such as confusion, boredom, and engagement. Incorporating emotion detection into learning systems helps in understanding the learner's state and improving the interaction accordingly. Despite this, many existing e-learning platforms do not utilize emotional feedback effectively. In the domain of **Natural Language Processing (NLP)**, models such as Transformer-based architectures (e.g., T5, BERT) have been widely used for grammar correction and language enhancement. These models are capable of understanding sentence structure and generating corrected text with high accuracy. Additionally, vocabulary enhancement techniques using synonym-based approaches have been used to improve language skills. However, most NLP-based tools function independently and are not integrated into a comprehensive learning system.

Furthermore, studies on **student performance analysis using machine learning algorithms**, such as Random Forest and Decision Trees, demonstrate effective prediction of student learning levels and performance trends. These models help in identifying weak areas and recommending suitable learning paths. However, these systems often lack real-time interaction and integration with other intelligent modules.

From the literature review, it is evident that while individual components such as adaptive learning, emotion detection, and NLP-based language correction have been developed, there is a lack of an integrated system that combines all these features into a single intelligent platform. Therefore, the proposed system aims to bridge this gap by integrating multiple AI techniques to create a comprehensive, interactive, and personalized e-learning application.

III. METHODOLOGY

The proposed system follows a structured methodology to develop an **AI-based E-learning Application** by integrating multiple machine learning models and technologies. The overall approach focuses on collecting input data, processing it using intelligent models, and generating personalized learning outputs.

Initially, the system collects input from the user in the form of text (and optionally image for emotion detection). The input is then processed through different modules, each designed to perform a specific task. The **grammar correction model**, based on a Transformer architecture (T5), analyzes the input sentence and generates a grammatically correct version. Simultaneously, the **vocabulary enhancement module** suggests improved word alternatives using a synonym-based lookup approach.

For understanding the learner's engagement, the system uses an **emotion detection model** built using Convolutional Neural Networks (CNN), which analyzes facial expressions captured through a webcam. The detected emotion helps in adjusting the learning experience dynamically.

The system also incorporates a **student analysis model** and an **adaptive learning model**, both implemented using the Random Forest algorithm. These models analyze parameters such as student performance, time spent, number of attempts, and emotional state to determine the learner's proficiency level and adjust the difficulty of learning content accordingly.

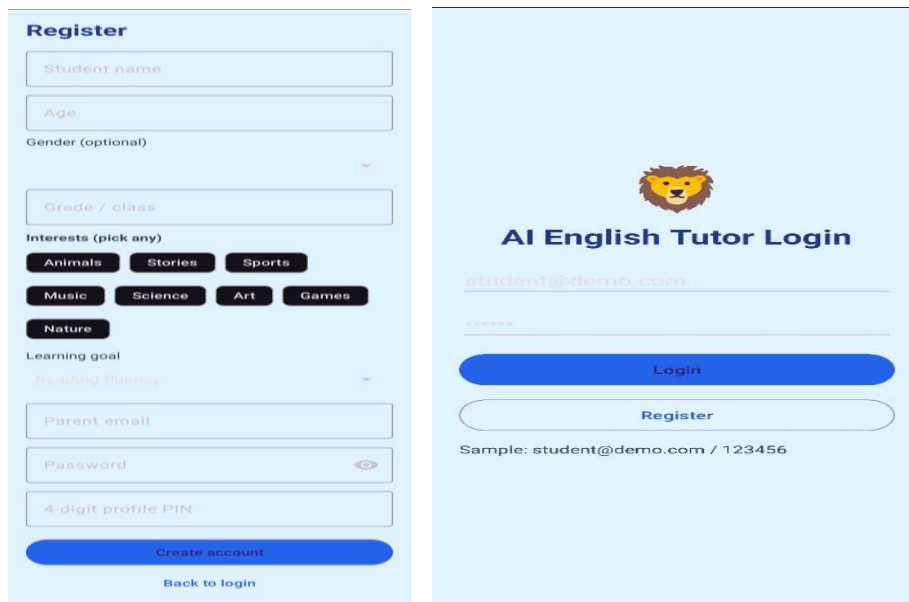
The processed outputs from all models are then combined to generate a comprehensive response that includes grammar correction, vocabulary suggestions, performance feedback, and adaptive learning recommendations. This response is delivered to the user through a user-friendly Android interface.

The backend of the system is developed using **Python and FastAPI**, which handles communication between the mobile application and machine learning models via REST APIs. The Android application, developed using **Kotlin**, sends user inputs to the backend and displays the processed results.

Overall, the methodology ensures a seamless integration of multiple AI components to provide a personalized, interactive, and efficient learning experience for students.

IV. EXPERIMENTAL RESULTS

Fig.1. Login and Registration Module (a) Registration form with student details and interests (b) Login screen
The system allows users to securely register and log in using email and password. Additional student information such as age, grade, and interests is collected to personalize the learning experience.

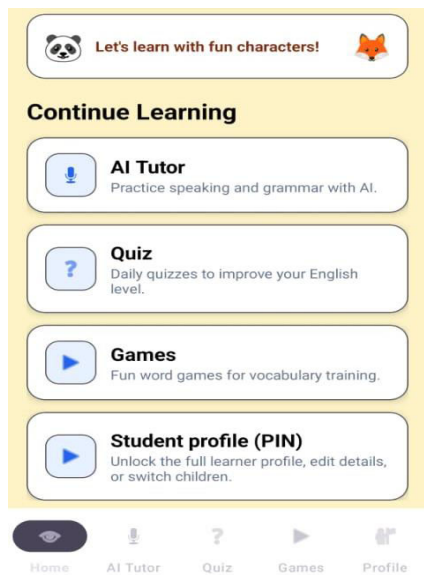


(a)

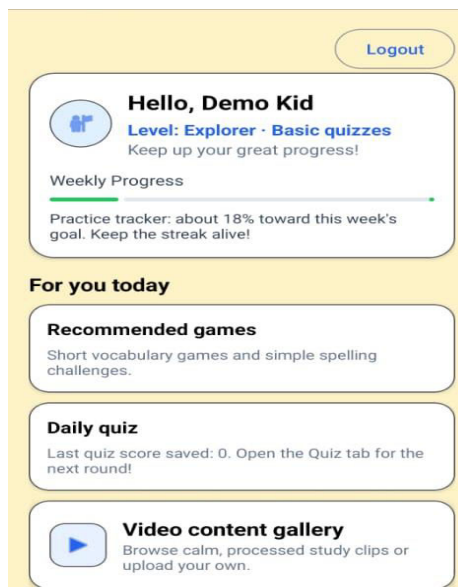
(b)

Fig.2. Dashboard and Progress Tracking (a1)(a2) Home screen showing student greeting and level (b) Weekly progress tracker (c) Recommended activities

The dashboard displays the student's current level, progress, and personalized recommendations such as quizzes, games, and AI tutor sessions.

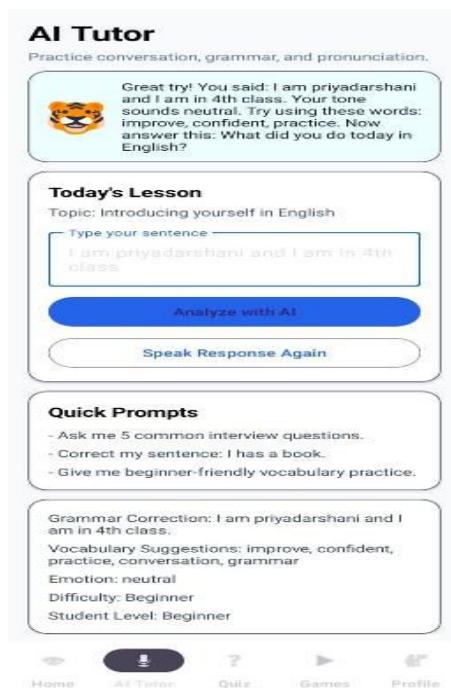


(a)

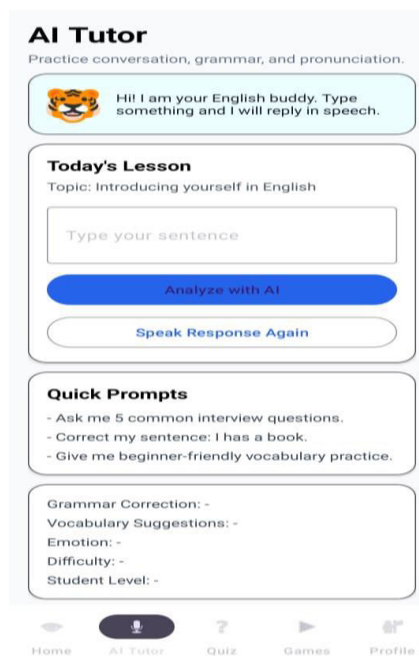


(b)

Fig.3. AI Tutor Module (a) Initial tutor interface ,User input sentence (b) AI-generated response with grammar correction, Vocabulary suggestions and emotion detection



(a)



(b)

Fig.4. Quiz Module (a) Question display and Multiple choice options (b) Score and difficulty level (c) Feedback message after answer The quiz module adapts difficulty based on student performance and provides immediate feedback to improve learning outcomes.

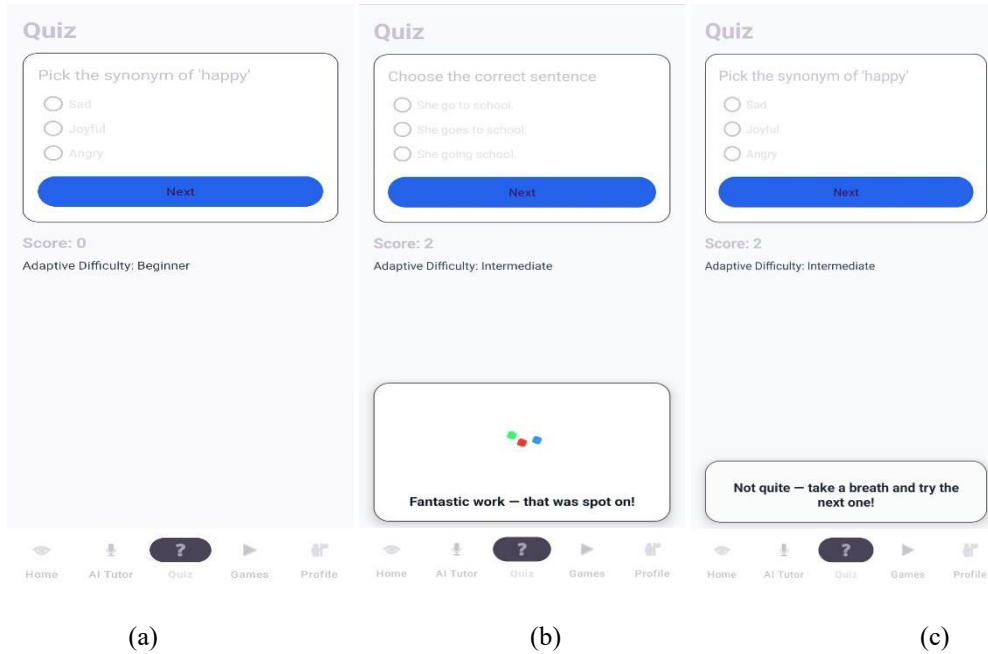


Fig.5. Games Module(a) Vocabulary matching game and Fill in the blank game (b) Grammar correction game (c) Result evaluation The games module enhances engagement by providing interactive exercises that improve vocabulary, spelling, and grammar skills.

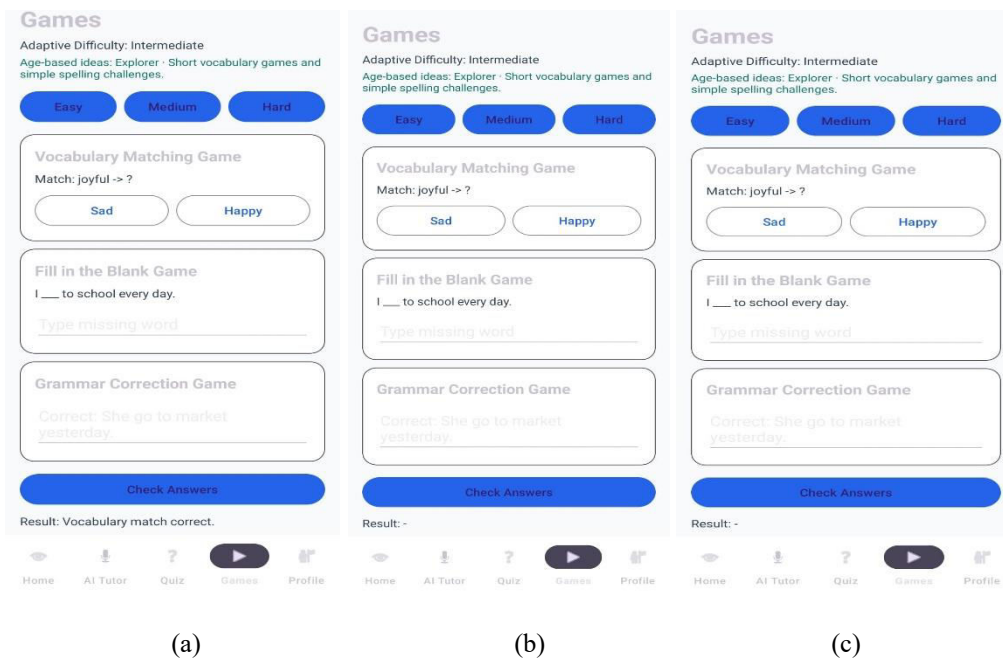
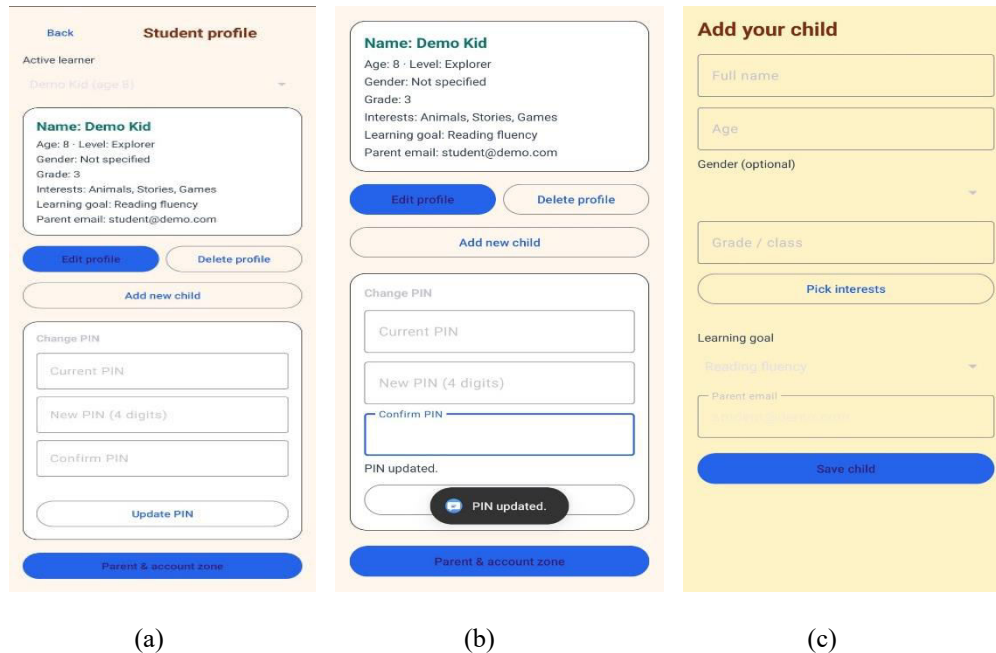


Fig.6. Student Profile and Security (a) Student profile details (b) PIN-based security system , Update PIN functionality (c) Add new child The system includes a secure profile management feature with PIN protection, allowing parents to manage multiple student profiles.



V. CONCLUSION

The proposed AI-based E-learning Application demonstrates how artificial intelligence can enhance the learning experience by providing personalized and adaptive learning support. The system integrates multiple models such as grammar correction, vocabulary enhancement, emotion detection, student analysis, and adaptive learning to improve both language skills and general knowledge. It provides real-time feedback and adjusts the difficulty level based on student performance, making learning more effective and engaging. Overall, the system offers a smart, user-friendly solution to overcome the limitations of traditional e-learning methods and supports continuous improvement in learning outcomes.

REFERENCES

- 1) T. Brown, B. Mann, N. Ryder et al., "Language Models are Few-Shot Learners," in Proc. NeurIPS, pp. 1877–1901, 2020.
- 2) C. Raffel, N. Shazeer, A. Roberts et al., "Exploring the Limits of Transfer Learning with a Unified Text-to-Text Transformer," Journal of Machine Learning Research, vol. 21, no. 140, pp. 1–67, 2020.
- 3) A. Vaswani, N. Shazeer, N. Parmar et al., "Attention is All You Need," in Proc. Advances in Neural Information Processing Systems (NeurIPS), pp. 5998–6008, 2017.
- 4) I. Goodfellow, Y. Bengio, and A. Courville, "Deep Learning," MIT Press, 2016.
- 5) P. Ekman and W. V. Friesen, "Facial Action Coding System: A Technique for the Measurement of Facial Movement," Consulting Psychologists Press, 1978.
- 6) S. Li and W. Deng, "Deep Facial Expression Recognition: A Survey," IEEE Transactions on Affective Computing, vol. 13, no. 3, pp. 1195–1215, 2022.
- 7) L. Breiman, "Random Forests," Machine Learning Journal, vol. 45, no. 1, pp. 5–32, 2001.
- 8) T. Chen and C. Guestrin, "XGBoost: A Scalable Tree Boosting System," in Proc. ACM SIGKDD, pp. 785–794, 2016.
- 9) D. Jurafsky and J. H. Martin, "Speech and Language Processing," 3rd ed., Pearson, 2021.
- 10) R. S. Baker and K. Yacef, "The State of Educational Data Mining in 2009: A Review and Future Visions," Journal of Educational Data Mining, vol. 1, no. 1, pp. 3–17, 2009.
- 11) A. Woolf, "Building Intelligent Interactive Tutors: Student-Centered Strategies for Revolutionizing E-learning," Morgan Kaufmann, 2010.
- 12) S. K. D'Mello and A. Graesser, "AutoTutor and Affective AutoTutor: Learning by Talking with Cognitively and Emotionally Intelligent Computers," ACM Transactions on Interactive Intelligent Systems, vol. 2, no. 4, 2012.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details