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Language Meets Logic: Enhancing Engineering Innovation Through Communication

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Abstract
Good communication in English plays a major role in both academic success and career growth. However, many students find it difficult to improve their spoken English, pronunciation, and interview skills because they don't get enough chances to practice or receive personal feedback in real-life situations. To address this problem, this work introduces an AI-based system designed to support English speaking assessment and interview preparation. The system provides real-time feedback using technologies like speech recognition and natural language processing, helping users understand their mistakes instantly.It evaluates important aspects such as grammar, fluency, vocabulary usage, clarity of pronunciation, and how relevant the responses are. In addition, it includes a mock interview feature where users can practice with role-based questions in a simulated interview environment created by an AI interviewer.The system also tracks user progress through a dashboard, allowing learners to see their improvement over time. Based on experimental observations, the system helps users build confidence in speaking, improve pronunciation accuracy, and perform better in interviews. Overall, this solution offers a practical and scalable way to support English language learning and prepare individuals for real-world communication and career opportunities

Keywords: *English Communication, Speech Recognition, Mock Interview, Artificial Intelligence, Pronunciation Assessment, NLP, Learning Analytics,Automatic Speech Recognition.*

1. Introduction
English is the primary language of communication in education, business, and technology, making spoken proficiency essential for academic and career success. However, many learners struggle with fluency, pronunciation, and confidence, particularly in interview situations, due to limited real-time practice and lack of personalized feedback. Traditional learning methods and existing digital tools mainly focus on grammar and written skills, offering minimal support for spoken communication. Most systems provide generalized feedback, lack adaptability to individual learners, and do not simulate real interview scenarios. Additionally, the absence of continuous performance tracking makes it difficult for users to monitor their progress. Automated spoken English evaluation also presents challenges such as variations in accent, speech patterns, and background noise, along with difficulty in assessing subjective aspects like fluency, confidence, and response relevance. Current AI-based solutions often address these aspects separately, resulting in incomplete learning experiences. Therefore, there is a need for an integrated system that combines real-time speech evaluation, AI-based interview simulation, personalized feedback, and continuous performance

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tracking. The proposed AI English Lab addresses this gap by providing an interactive and scalable platform for improving communication and interview skills.

2. Methods

This section presents the design and implementation of the proposed AI English Lab system. It describes the system requirements, architecture, working methodology, and evaluation process used to assess spoken English and support interview preparation. The approach integrates speech recognition, natural language processing, and artificial intelligence techniques to provide real-time feedback and personalised learning.

2.1.System Requirements and Design Considerations

The design and implementation of the proposed AI English Lab system require careful consideration of functional capabilities, system performance, scalability, and user experience. This section outlines the essential system requirements and key architectural considerations necessary to ensure reliable, efficient, and scalable operation.

- Modular Architecture: The system is designed using a modular architecture to ensure flexibility, maintainability, and scalability. Core components such as speech processing, linguistic evaluation, adaptive learning modules, and analytics operate independently while remaining interconnected. This structure allows easy integration of future enhancements and simplifies system upgrades.
- Real-Time Processing: Real-time responsiveness is a key design requirement. The system must provide immediate feedback with minimal latency to maintain interactive learning. Efficient ASR and NLP pipelines are implemented to ensure fast and accurate speech analysis.
- Multi-Parameter Evaluation Strategy: The system employs a multi-dimensional evaluation framework that analyzes grammar accuracy, fluency, vocabulary richness, pronunciation clarity, and response relevance. This holistic approach ensures objective and comprehensive communication assessment.
- Adaptability and Personalization : The system dynamically adjusts difficulty levels and feedback depth based on user proficiency. This adaptive mechanism ensures personalized learning paths and continuous improvement.
- Scalability and Extensibility: The architecture is designed to support multiple users and future enhancements such as emotion-aware feedback, accent adaptation, and multi-user interview simulations, making the system suitable for large-scale deployment.

2.2.Proposed System and Methodology

The proposed AI English Lab system integrates speech recognition, natural language processing, and artificial intelligence techniques to provide real-time spoken English assessment and adaptive interview preparation. The system is designed to enhance communication proficiency, improve interview readiness, and provide personalized feedback through continuous evaluation. By combining speech processing with intelligent analytics, the proposed framework enables dynamic and interactive language learning.

2.2.1. System Architecture

The system architecture consists of four primary components: the User Interface Module, the Speech Processing Unit, the AI Evaluation Engine, and the Performance Analytics Module. The User Interface Module serves as the interaction layer, allowing users to log in, attempt assessments, participate in mock interviews, and access performance dashboards. The Speech Processing Unit captures spoken input through a microphone and processes it using an Automatic Speech Recognition (ASR) system to convert speech into text. The converted text is forwarded to the AI Evaluation Engine, which applies Natural Language Processing (NLP) techniques to analyze grammar accuracy, vocabulary richness, sentence coherence, pronunciation clarity, and semantic relevance. The engine computes multi-parameter scores and classifies users into appropriate proficiency levels. The Performance Analytics Module stores session data and visualizes user progress through dashboards and graphical reports.

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This modular architecture ensures scalability and allows integration of future enhancements such as emotion-aware feedback and multi-user interview simulation shown in Figure 1.

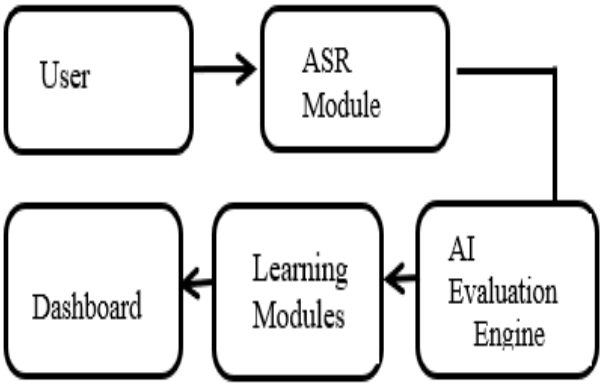

Figure 1 Proposed System Architecture

2.2.2. Working Methodology

The workflow of the proposed system begins when the user logs into the platform and initiates an assessment or mock interview session. For speaking assessment, the system captures real-time audio input via a microphone. The ASR module converts the speech signal into text while simultaneously extracting acoustic-temporal features relevant to fluency analysis. The textual output is processed by the NLP module to evaluate grammatical correctness, lexical diversity, and contextual coherence. Pronunciation clarity is assessed using phonetic comparison and confidence scoring mechanisms. Fluency is measured using speech rate, pause duration, and hesitation frequency. Based on the evaluated parameters, the AI Evaluation Engine computes individual metric scores and generates an overall communication score. In the mock interview module, role-specific questions are generated dynamically, and responses are evaluated in real time. Immediate feedback and improvement suggestions are displayed to the user after each response. All performance metrics are stored in the database and continuously updated in the analytics dashboard, allowing users to monitor improvement across multiple sessions shown in Figure 2.

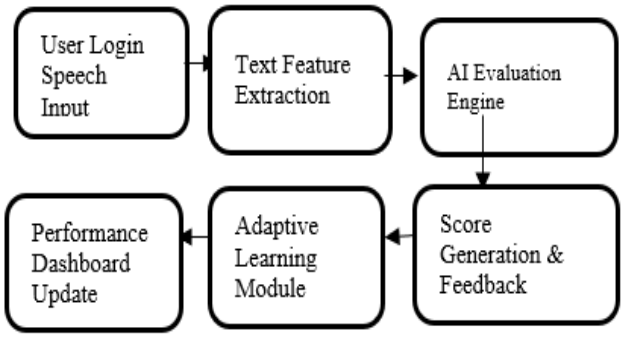

Figure 2 AI English Lab Workflow

2.2.3. Communication Assessment and Adaptive Feedback

Communication assessment is performed using a multi-dimensional evaluation strategy. Unlike traditional systems that rely on isolated grammar correction, the proposed system simultaneously analyzes grammar accuracy, vocabulary richness, pronunciation clarity, fluency continuity, and response relevance. Fluency analysis is conducted using objective speech features such as words per minute, average pause duration, and hesitation rate. Vocabulary richness is evaluated using lexical diversity metrics, while grammar accuracy is determined through syntactic and semantic analysis. These metrics are aggregated to compute an overall communication effectiveness score. The adaptive feedback mechanism ensures that users receive personalized recommendations based on identified weaknesses. Lighter feedback is provided for minor errors, while structured improvement suggestions are given for significant deficiencies. The system dynamically adjusts task difficulty according to proficiency classification, ensuring continuous learning progression. By integrating speech recognition, linguistic analysis, and adaptive evaluation within a unified framework, the proposed AI English Lab provides an intelligent, scalable, and practical solution for modern English communication and interview training.

2.2.4. Proposed Algorithm

The proposed AI English Lab algorithm performs real-time spoken English assessment through a multi-stage processing pipeline. The system integrates

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speech acquisition, speech-to-text conversion, acoustic feature extraction, linguistic analysis, multi-parameter scoring, adaptive feedback generation, and performance tracking. The algorithm ensures holistic communication evaluation rather than isolated grammar or pronunciation correction.

1. Speech Input Acquisition
   - Capture real-time audio input through microphone.
   - Apply noise filtering and signal normalization.
   - Segment audio into speech frames for processing.

Mathematically, the speech signal S(t) is segmented into frames:

$$Si(t)=S(t).w(t-iT)$$

where:

- w(t)is the window function
- T is frame shift interval

2. Automatic Speech Recognition
   - Convert speech signal into textual transcription.
   - Extract word timestamps.
   - Generate confidence scores for each recognized word.
3. Acoustic Feature Extraction

Extract temporal speech features

   - Speech Rate (Words Per Minute)
     Speech Rate =
   - Average Pause Duration
     Pause =
   - Hesitation Frequency
4. Multi-Parameter Scoring

Each evaluation metric is normalized between 0 and 100:

   - Grammar Score G
   - Fluency Score F
   - Vocabulary Score V
   - Pronunciation Score P
   - Relevance Score R

Overall Communication Score:
OCS=W1G+W2F+W3V+W4P+w5R
where W1+W2+W3+W4+W5=1

5. Proficiency Classification Based on OCS:
   - Beginner: OCS<50
   - Intermediate: 50≤OCS<75
   - Advanced: OCS≥75

3. Results And Discussion

This section presents the experimental results obtained from the implementation of the proposed AI English Lab system and discusses its effectiveness in improving English communication skills and interview preparedness. The evaluation focuses on assessment accuracy, user performance improvement, system responsiveness, and overall usability. The results demonstrate that the proposed system provides reliable evaluation, personalized feedback, Measurable learning outcomes. The AI English Lab system was evaluated using a group of undergraduate and graduate students with varying levels of English proficiency. Users interacted with the platform through speaking assessments, conversation practice, and mock interview sessions. The experiments were conducted on a standard personal computing environment with a microphone input and internet connectivity. Speech input was processed using an automatic speech recognition module, while large language models were employed for linguistic evaluation and feedback generation. User sessions were logged to collect assessment scores, practice duration, and improvement trends. The system was tested across multiple sessions to evaluate consistency and learning progression in Figure 3.

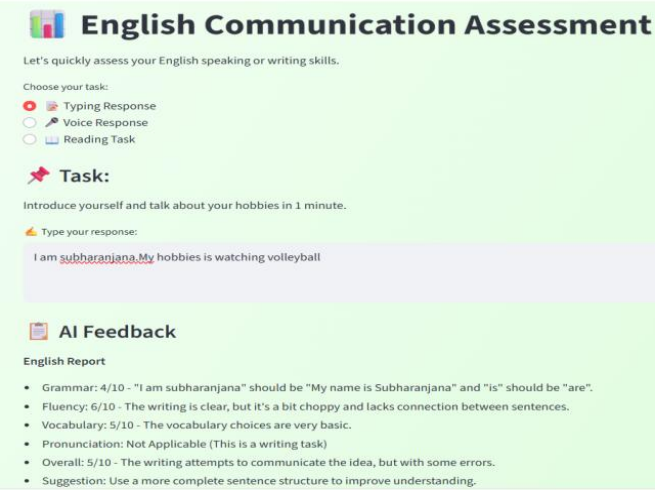

Figure 3 Communication Assessment

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The performance of the proposed system was evaluated using the following metrics: Grammar Accuracy Score (%): Measures correctness of sentence structure and grammatical usage. Fluency Score: Evaluates smoothness and continuity of speech. Vocabulary Richness Score: Assesses diversity and appropriateness of word usage. Pronunciation Clarity Score: Measures phonetic accuracy and articulation. Overall Communication Score: Combined metric reflecting overall speaking effectiveness. User Improvement Rate: Measures score progression over repeated sessions. Response Latency: Time taken by the system to generate feedback after user input. These metrics provide a comprehensive evaluation of both system performance and learning effectiveness. Results show that the system consistently provided accurate and meaningful feedback across all assessment components. Grammar and vocabulary analysis successfully identified common errors such as incorrect tense usage, sentence fragmentation, and limited lexical diversity. Pronunciation analysis effectively highlighted mispronounced words and unclear articulation. The AI-generated feedback was concise and actionable, enabling users to immediately understand their weaknesses and apply corrective measures. Users reported that example answers and improvement suggestions were particularly useful in enhancing response quality during mock interviews in Figure 4.

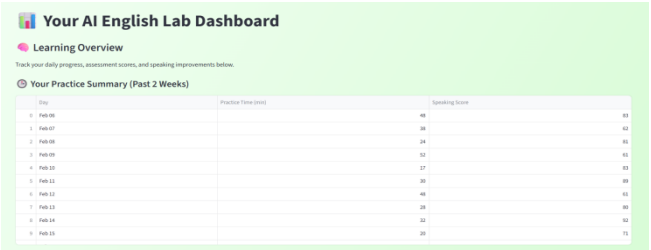

Figure 4. illustrates the improvement trends of users over multiple practice sessions. A steady increase in grammar accuracy, fluency, and pronunciation scores was observed.

On average, users demonstrated an improvement of 15–25% in overall communication scores after five practice sessions shown in Table 1.

Table 1 User Performance Scores Across Three Practice Sessions

Metric	Session 1	Session 2	Session 3	Improvement
Grammar Accuracy (%)	58.2	63.5	68.9	+18.2%
Fluency Score (%)	52.4	57.8	63.2	+20.5%
Vocabulary Richness (%)	55.1	59.3	64.7	+19.1%
Pronunciation Clarity (%)	49.6	54.2	60.1	+21.7%
Overall Comm. Score (%)	**53.8**	**59.2**	**64.7**	**+20.8%**

The adaptive nature of the system played a significant role in this improvement. As user proficiency increased, the system adjusted question difficulty and feedback depth, ensuring continuous learning without stagnation shown in Figure 5.

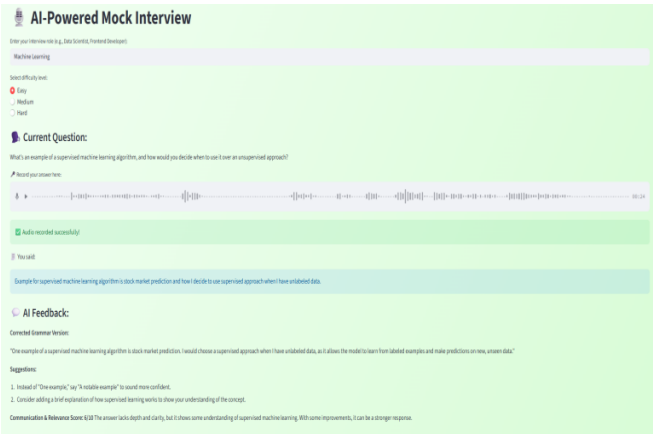

Figure 5 AI Mock Interview

The AI Mock Interview module successfully simulated real interview conditions. Users reported increased confidence and reduced hesitation during subsequent interview sessions. The role-based and difficulty-specific question generation enabled focused preparation for different job profiles in Figure 6.

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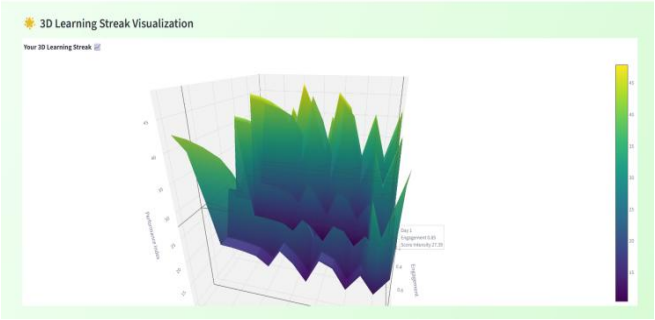

Figure 6. Graph

The analytics dashboard provided a clear visualisation of user progress through graphs and structured reports. Users were able to monitor improvement trends, identify weak areas, and set learning goals accordingly. This transparency significantly increased user motivation and learning consistency. The session-based data storage ensured personalised feedback and long-term progress analysis, which is not commonly available in traditional language learning platforms.

Table 2 Comparison of AI English Lab with Existing Systems

Feature	Proposed System	Existing System
Real-Time Speech Feedback	Yes	Yes
Pronunciation Assessment	Yes	Yes
Mock Interview Module	Yes	No
Adaptive Personalized Feedback	Yes	Partial
Progress Tracking Dashboard	Yes	Partial
Multi-Parameter Scoring	Yes (5 params)	Partial

Conclusion

This paper presented the design and implementation of the AI English Lab, an intelligent system developed to enhance spoken English proficiency and interview preparedness through real-time assessment and adaptive learning. The proposed framework integrates Automatic Speech Recognition, Natural Language Processing, and a multi-parameter AI evaluation engine to provide comprehensive analysis of grammar accuracy, fluency, vocabulary richness, pronunciation clarity, and overall communication effectiveness. Unlike traditional language learning platforms that focus on isolated skills, the proposed system offers a unified architecture that combines speech processing, linguistic evaluation, mock interview simulation, and performance analytics within a single scalable framework. The incorporation of feature-level fluency analysis using speech rate, pause duration, and hesitation frequency ensures objective and measurable evaluation. Additionally, the adaptive feedback mechanism personalises learning paths based on user performance, promoting continuous improvement. Experimental results demonstrate consistent enhancement across all communication metrics over multiple practice sessions, validating the effectiveness of the proposed approach. The reduction in response latency further confirms the system's capability to provide near real-time feedback, improving user engagement and learning efficiency. Overall, the AI English Lab establishes a practical, scalable, and intelligent solution for modern English communication training. Future work may focus on integrating emotion-aware feedback, accent adaptation, multimodal interaction, and large-scale deployment to further enhance personalisation and real-world applicability.

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