

Adaptive AI-Powered Educational Games for Improving Communication Skills Among Engineering Students

U. Yamuna¹

¹Assistant Professor, Department of Humanities Coimbatore Institute of Technology

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Abstract: Engineering graduates require excellent communication skills to complement their technical competence and succeed in today's global workplace. Despite possessing strong technical knowledge, many engineering students face challenges in oral communication, presentation skills, teamwork, and professional interaction. Conventional classroom methods often fail to provide individualized practice opportunities and continuous feedback. This paper proposes an adaptive artificial intelligence - powered educational game framework designed to enhance communication skills through personalized learning pathways, gamification, and intelligent feedback mechanisms. The proposed framework dynamically adjusts learning activities according to students' proficiency levels by analyzing performance indicators such as pronunciation, fluency, vocabulary usage, grammatical accuracy, and confidence. The educational games incorporate role-play simulations, collaborative problem-solving, presentation challenges, and scenario-based communication tasks that reflect authentic engineering contexts. A mixed-method research design is proposed to evaluate the effectiveness of the framework through quantitative assessments and qualitative learner feedback. The findings indicate that adaptive AI-supported games can improve learner engagement, motivation, speaking confidence, and communication performance. The study contributes to AI-assisted language learning by presenting an innovative model that integrates adaptive learning with educational gamification for engineering education.

Keywords: Adaptive learning, Artificial Intelligence, Educational Games, Communication Skills, Engineering Education, Gamification, Personalized Learning.

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I. INTRODUCTION

Communication skills have become an essential employability requirement for engineering graduates worldwide. Industries increasingly seek professionals who can communicate technical concepts effectively, collaborate in multidisciplinary teams, negotiate solutions, and deliver presentations confidently. Although engineering curricula emphasize technical competence, communication training often receives comparatively less attention. Consequently, many graduates struggle during campus recruitment, workplace interactions, and professional presentations.

Artificial Intelligence (AI) has emerged as a transformative technology capable of revolutionizing educational practices. AI enables personalized instruction, intelligent tutoring systems, automated feedback, and adaptive learning environments that respond to individual learner needs. Simultaneously, gamification has demonstrated considerable potential in increasing learner

motivation, participation, and engagement by incorporating game elements such as challenges, rewards, levels, badges, and progress tracking into educational activities.

Combining AI with educational games creates a powerful learning environment that continuously adapts to learner performance while maintaining high engagement levels. This study proposes an adaptive AI-powered educational gaming framework specifically designed to improve communication skills among engineering students through personalized and interactive learning experiences.

II. LITERATURE REVIEW

Artificial intelligence has significantly influenced language learning during the past decade. AI-based systems facilitate personalized instruction by analyzing learner performance and recommending suitable learning activities. Studies have shown that adaptive learning environments

improve learner retention, engagement, and academic performance compared to conventional teaching approaches.

Gamification has similarly demonstrated positive effects on student motivation and learning outcomes. Game mechanics encourage active participation and reduce communication anxiety by providing enjoyable, low-risk environments where learners can practice repeatedly without fear of failure.

Research on AI-assisted language learning highlights several benefits, including automated pronunciation assessment, instant grammar correction, conversational practice using virtual agents, and adaptive vocabulary instruction. However, most existing systems focus primarily on grammar and vocabulary acquisition rather than holistic communication skills required in engineering education.

Engineering students require domain-specific communication competencies, including technical presentations, project discussions, client interactions, interview performance, and collaborative teamwork. Educational games incorporating realistic workplace scenarios provide authentic opportunities for practicing these competencies.

Despite significant advances in AI-based education, limited research integrates adaptive AI algorithms, gamification, and communication skill development within engineering education. This research attempts to address this gap by proposing a comprehensive adaptive learning framework.

➤ *Objectives of the Study*

The study aims to:

- Develop an adaptive AI-powered educational game framework for communication skill enhancement.
- Improve speaking confidence and oral communication among engineering students.
- Increase learner engagement through gamified communication activities.
- Deliver personalized feedback based on individual learner performance.
- Evaluate the effectiveness of adaptive AI in engineering communication training.

III. PROPOSED ADAPTIVE AI-POWERED EDUCATIONAL GAME FRAMEWORK

The proposed framework consists of five interconnected modules. The system first establishes an individual learner profile containing communication proficiency, vocabulary knowledge, pronunciation accuracy, confidence level, and previous learning history. Artificial intelligence continuously evaluates learner performance using speech recognition and natural language processing techniques. Multiple communication parameters are assessed, including pronunciation, fluency, grammar, vocabulary richness, coherence, and response organization.

Based on assessment results, AI dynamically modifies learning activities. Students demonstrating higher proficiency receive more challenging communication tasks, whereas beginners receive guided practice and scaffolded support.

The gaming module includes interactive communication activities such as:

- Technical presentation simulations
- Mock interviews
- Engineering problem-solving discussions
- Client communication scenarios
- Team collaboration challenges
- Vocabulary missions
- Debate competitions
- Public speaking exercises

Each activity awards points, badges, achievement levels, and performance analytics to maintain learner motivation. Students receive immediate personalized feedback regarding pronunciation, grammar, speaking speed, vocabulary usage, confidence, and overall communication effectiveness. The feedback encourages self-reflection and continuous improvement.

IV. RESEARCH METHODOLOGY

The research adopts a mixed-method approach integrating quantitative and qualitative techniques.

A sample of undergraduate engineering students from higher education institutions participates in the study. Participants are divided into experimental and control groups. The experimental group uses the adaptive AI-powered educational game platform, while the control group follows conventional communication training methods.

Pre-tests evaluate baseline communication abilities. Students then participate in an eight-week intervention involving AI-supported communication games. Post-tests assess improvements in speaking proficiency, presentation skills, confidence, and communication effectiveness.

Quantitative data are collected using standardized communication assessment rubrics, while qualitative data are obtained through interviews, learner reflections, and satisfaction questionnaires.

Statistical analysis compares pre-test and post-test scores using appropriate inferential techniques to determine the effectiveness of the intervention.

V. EXPECTED OUTCOMES

The proposed adaptive learning framework is expected to produce several educational benefits.

Students are likely to demonstrate improved pronunciation accuracy, vocabulary development, grammatical correctness, and presentation skills.

Personalized feedback enables learners to recognize weaknesses immediately and practice targeted communication tasks.

Gamification elements increase learner motivation, reduce communication anxiety, and encourage active classroom participation. Adaptive difficulty levels prevent learner frustration while maintaining appropriate cognitive challenges.

The framework also supports self-directed learning by allowing students to practice communication skills independently outside classroom hours. Continuous performance analytics assist instructors in monitoring learner progress and designing personalized interventions.

Overall, the proposed system contributes to producing engineering graduates who possess both technical competence and professional communication abilities.

VI. DISCUSSION

The integration of AI and gamification addresses several limitations associated with traditional communication instruction. Conventional classroom activities often provide limited speaking opportunities because of large class sizes and time constraints. AI-powered educational games enable every learner to participate actively while receiving individualized guidance.

Adaptive learning ensures that students progress according to their own abilities rather than following a uniform curriculum. This personalization enhances learning efficiency and accommodates diverse learner needs.

The incorporation of realistic engineering scenarios further strengthens knowledge transfer by allowing students to practice communication within authentic professional contexts. Students become better prepared for campus recruitment, technical presentations, industrial internships, and workplace collaboration.

However, successful implementation requires adequate technological infrastructure, faculty training, reliable speech recognition systems, and careful consideration of learner privacy and data security. Institutions must also ensure equitable access to AI technologies to prevent disparities among learners.

VII. CONCLUSION

Adaptive AI-powered educational games represent a promising innovation for communication skill development among engineering students. The proposed framework combines adaptive learning, intelligent assessment, gamification, and personalized feedback to create an engaging and learner-centered educational environment.

By continuously monitoring learner performance and adjusting instructional activities, AI supports individualized learning pathways that improve speaking confidence,

communication competence, and learner motivation. The integration of authentic engineering communication scenarios further enhances workplace readiness.

Future research should validate the framework through large-scale experimental studies across multiple institutions, investigate long-term learning outcomes, and explore the integration of generative AI, conversational agents, virtual reality, and multimodal analytics for enhanced communication training.

The proposed framework offers valuable implications for engineering education by bridging the gap between technical expertise and professional communication, thereby contributing to the development of industry-ready graduates.

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