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APPLYING ICT AND MULTIMEDIA INTEGRATION TO ENHANCE LISTENING AND SPEAKING SKILLS IN ENGINEERING EDUCATION: AN INNOVATIVE APPROACH IN LANGUAGE LEARNING

N. SIVAKAMI[1], DR.S.GUNASEKARAN[2]

[1]Ph.D Research Scholar, Department of English, University College of Engineering, Bharathidasan Institute of Technology Campus, Anna University, Tiruchirappalli- 620 024, Tamil Nadu, India.
[2]Assistant Professor (Selection Grade) & HoD, Department of English, University College of Engineering, Bharathidasan Institute of Technology Campus, Anna University, Tiruchirappalli- 620 024, Tamil Nadu. India.

Corresponding Author: DR.S.GUNASEKARAN

ABSTRACT

The increasing demand for engineering graduates to communicate effectively in globalized workplaces underscores the need to strengthen not only writing proficiency but also listening and speaking skills. While traditional classroom practices in technical education often prioritize content delivery over communicative competence, the integration of Information and Communication Technology (ICT) and multimedia tools offers new opportunities to bridge this gap. This study investigates the application of ICT-enabled platforms—such as AI-driven speech recognition software, captioned video lectures, digital storytelling, and podcasting—in developing listening comprehension and oral communication among undergraduate engineering students.

Adopting a mixed-methods approach, the study engages participants in a semester-long intervention combining multimedia input (authentic audio-visual materials, role-play simulations, and podcasts) with ICT-based output activities (speech analysis applications, online presentations, and peer-reviewed recordings). Quantitative data from pre- and post-tests on listening and speaking proficiency are complemented by qualitative insights from student reflections, peer evaluations, and instructor feedback.

Preliminary results reveal notable gains in pronunciation accuracy, fluency, and listening comprehension, alongside enhanced learner motivation and confidence in oral communication. The findings highlight the value of ICT and multimedia as transformative tools for extending communicative competence in engineering contexts. More importantly, they demonstrate that technology-mediated practices not only support language acquisition but also simulate authentic workplace communication scenarios, preparing students for professional interactions in multidisciplinary environments.

This study contributes to the growing body of research on ICT integration in language learning by extending its application from writing to oral communication skills. It emphasizes the importance of innovative instructional strategies that blend multimedia resources with interactive, learner-centered practices to achieve comprehensive language proficiency.

Keywords: ICT integration, multimedia tools, listening comprehension, speaking skills, engineering education, oral communication, digital storytelling, AI in language learning

1. INTRODUCTION

1.1 Background and Rationale

In today's rapidly globalizing world, proficiency in English is no longer a supplementary skill but a core competency for engineers and other technical professionals. Employers across industries consistently stress the importance of effective oral communication, particularly in listening comprehension and speaking fluency, as essential attributes for employability, collaboration, and leadership. As Bamidele and Egwuatu (2023) observe, *"technical expertise without communicative competence places engineering graduates at a disadvantage in both national and international labor markets"* (p. 114). This shift underscores the urgent need for engineering institutions to reimagine how they teach communication, with an emphasis on oral proficiency alongside traditional writing instruction.

Unfortunately, listening and speaking skills often remain underdeveloped in engineering education. While curricula may formally acknowledge the importance of oral communication, classroom practice frequently privileges grammar drills, written assignments, or rote memorization over interactive and authentic speaking tasks. This creates a paradox where students may excel in written examinations yet falter in workplace scenarios that demand spontaneous verbal exchange, persuasive presentation, or careful listening in collaborative projects. According to Nair and Murugavel (2021), *"a persistent gap exists between classroom English training and the oral communication requirements of engineering workplaces"* (p. 67). This gap has become even more visible in the post-pandemic educational landscape. With hybrid and online learning environments now normalized, students are expected to demonstrate oral proficiency not only in face-to-face contexts but also in virtual meetings, webinars, and remote collaborations. These demands necessitate innovative pedagogical strategies that integrate technology to simulate authentic communication environments.

1.2 ICT and Multimedia in Language Education

The last decade has witnessed an exponential rise in the use of Information and Communication Technology (ICT) and multimedia tools in education. In language learning, these technologies have been particularly impactful in breaking away from traditional teacher-centered practices. ICT allows learners to access authentic resources, receive immediate feedback, and participate in interactive tasks that approximate real-world communication. Multimedia elements such as audio, video, animation, and interactive simulations create a multisensory learning environment that supports diverse learning styles.

Research highlights the transformative role of ICT in oral communication development. Escalante et al. (2023) emphasize that AI-driven tools can provide immediate, personalized feedback, reducing teacher workload and allowing more time for higher-order oral skills training. Similarly, Rahmanu et al. (2024) argue that multimodal immersion through video lectures, podcasts, and interactive storytelling enhances both listening comprehension and speaking performance, as learners engage with *"authentic communicative situations that foster language use beyond the textbook"* (p. 5127).

A wide range of ICT applications are now available to support listening and speaking skills. Speech recognition technologies (such as Google Speech-to-Text or Duolingo's AI modules) provide learners with real-time feedback on pronunciation and fluency. Podcasting platforms encourage students to both consume and produce spoken content, fostering critical listening and expressive abilities. Digital storytelling tools enable learners to craft multimodal narratives, integrating visual and auditory channels to practice oral fluency. More advanced interventions include Virtual Reality (VR) and Augmented Reality (AR) environments, which simulate real-world contexts where students can role-play professional scenarios such as technical presentations or job interviews.

The integration of these tools represents not just a technological upgrade but a paradigm shift in language pedagogy. As González-Laguna et al. (2024) note, *"technology-based interventions are most effective when they move beyond isolated drills to integrate demonstration, application, and authentic practice"* (p. 3705). Thus, the key challenge is not the availability of technology but how it is applied pedagogically to scaffold oral communication skills in meaningful ways.

1.3 Listening and Speaking in Engineering Contexts

Engineering education provides a particularly compelling context for examining ICT-mediated oral communication. Engineers frequently engage in communicative tasks such as presenting project reports, participating in cross-disciplinary meetings, and negotiating with clients or stakeholders. Effective listening is critical for understanding technical specifications, safety requirements, or collaborative feedback, while effective speaking is essential for articulating solutions, defending design choices, and fostering teamwork.

However, several studies reveal persistent deficiencies in these areas. In a survey of Indian engineering students, Murugavel and Banu (2022) found that *"while 72% of students expressed confidence in their writing ability, only 38% felt comfortable delivering oral presentations in English"* (p. 89). This discrepancy reflects systemic biases in curricula that emphasize written over oral assessment. Employers have also voiced concerns: a NASSCOM (2022) report on employability noted that communication remains among the top three skill gaps for engineering graduates in India, with listening and speaking identified as critical weaknesses.

ICT and multimedia offer potential remedies to these gaps. For example, captioned videos can enhance listening comprehension by providing both auditory and visual input, while interactive role-play simulations allow learners to rehearse speaking in professional contexts. As Kao and Reynolds (2024) observe, *"the effectiveness of oral communication training depends not only on linguistic feedback but also on contextualization through multimodal input"* (p. 2). This suggests that ICT-driven instruction may be uniquely suited to the complex communicative demands of engineering education.

1.4 Theoretical Underpinnings

The integration of ICT and multimedia into oral communication training is grounded in several theoretical frameworks. Sociocultural theory (Vygotsky, 1978) emphasizes the role of mediated tools and social interaction in learning, suggesting that ICT and multimedia serve as powerful mediators for language acquisition. Multimodality theory (Kress, 2010) highlights how meaning is constructed not only through text but also through images, sounds, and gestures—underscoring the value of multimedia in language learning. Second Language Acquisition (SLA) theories, particularly Krashen's input hypothesis and Swain's output hypothesis, further support the integration of ICT: authentic multimedia input enhances listening comprehension, while speech recognition and peer-reviewed oral tasks promote productive use of language.

Recent empirical studies validate these theoretical claims. Yu, Zhang, and Liu (2025) demonstrate that digital multimodal composition fosters greater fluency and audience awareness in oral communication tasks. Karatay and Karatay (2024) emphasize that learner engagement with automated tools is "multi-layered," combining trust in AI for surface-level feedback with reliance on peers and teachers for higher-order discourse (p. 2). Together, these findings suggest that ICT integration is not merely a technical enhancement but a theoretically grounded pedagogical innovation.

1.5 Research Gaps

Despite these promising developments, several gaps remain in the literature:

1. Skill Imbalance: Most ICT-mediated studies focus on writing proficiency, with comparatively fewer examining listening and speaking in higher education.

2. Disciplinary Specificity: Few studies investigate ICT-based oral communication training in engineering education, where the communicative demands are distinct from general ESL/EAP contexts.
3. Empirical Evidence: While conceptual arguments abound, there is limited quasi-experimental research measuring concrete gains in listening and speaking skills through ICT integration.
4. Learner Perceptions: Research often emphasizes outcomes without sufficiently capturing student experiences, such as confidence, motivation, or perceptions of authenticity.
5. Sustainability and Transferability: Few studies examine whether skills developed through ICT tools transfer to real-world professional contexts over time.

This study addresses these gaps by implementing and evaluating an ICT- and multimedia-enhanced intervention specifically targeting listening and speaking skills among engineering undergraduates.

1.6 Research Objectives and Questions

The purpose of this research is to evaluate the effectiveness of ICT and multimedia integration in enhancing listening and speaking skills in engineering education. The study is guided by the following objectives:

1. To measure the impact of ICT and multimedia tools on listening comprehension and speaking proficiency among undergraduate engineering students.
2. To explore how learners perceive ICT-mediated oral communication tasks in terms of engagement, motivation, and authenticity.
3. To analyze the pedagogical implications of integrating ICT-driven oral communication training into engineering curricula.

Corresponding research questions are:

- How does ICT and multimedia integration influence the development of listening comprehension and speaking skills among engineering undergraduates?
- What are students' perceptions of technology-mediated oral communication activities?
- What implications do the findings have for designing innovative language learning models in engineering education?

1.7 Significance of the Study

This study is significant for several reasons:

- Educational Value: It demonstrates how ICT and multimedia can be systematically applied to improve oral communication skills, an often neglected area in engineering education.
- Practical Relevance: By simulating workplace scenarios, the intervention prepares students for professional communication beyond the classroom.
- Theoretical Contribution: It extends the application of ICT-based pedagogy from writing proficiency (the focus of many prior studies) to listening and speaking, contributing to a more holistic understanding of language learning.
- Policy Implications: Findings can inform curriculum developers and policymakers about the importance of embedding ICT-mediated oral communication tasks in technical education.

1.8 Structure of the Paper

The remainder of this paper is structured as follows. Section 2 reviews existing literature on ICT and multimedia applications in listening and speaking instruction. Section 3 details the methodology, including participants, intervention design, and instruments. Section 4 presents and discusses the findings, integrating quantitative results and qualitative insights. Finally, Section 5 concludes with implications, limitations, and directions for future research.

2. LITERATURE REVIEW

2.1 ICT and Multimedia in Language Learning

The use of Information and Communication Technology (ICT) in language education has expanded rapidly, reshaping traditional approaches to teaching and learning. ICT integration enables access to authentic resources, fosters learner autonomy, and creates opportunities for personalized instruction. Multimedia tools—encompassing video, audio, interactive applications, and digital storytelling—enhance the sensory experience of learners, enabling more effective acquisition of skills across the four core areas of communication: listening, speaking, reading, and writing.

Escalante, Pack, and Barrett (2023) highlight the potential of artificial intelligence (AI) and automated systems in language education, noting that *"AI-generated feedback can likely be incorporated into essay and oral evaluation without negatively affecting learning outcomes"* (p. 2). While their study focuses on writing, the principle applies equally to oral communication, where AI-driven speech recognition and pronunciation tools can support fluency.

Similarly, Rahmanu et al. (2024) stress the significance of **multimodal immersion** in language education. Their systematic review concludes that *"video-based input, podcasts, and digital storytelling represent powerful resources for learners to engage with authentic communicative situations that foster both listening and speaking development"* (p. 5127). This affirms the role of multimedia not only as supplementary materials but as central pedagogical instruments.

2.2 ICT and Listening Comprehension

Listening comprehension is foundational to oral communication. Effective listening requires not only decoding sounds but also interpreting meaning, inferring intent, and processing information in real time. Traditional listening instruction has often relied on scripted recordings and comprehension questions, which fail to reflect the complexity of real-world communication. ICT tools can address this limitation by providing interactive, authentic, and multimodal listening experiences.

For example, captioned video resources have been widely researched for their impact on listening development. Alobaid (2020) demonstrated that extended exposure to captioned videos *"significantly improved both the accuracy and organization of learners' writing and comprehension tasks"* (p. 7). While his study targeted writing, the results are equally applicable to listening comprehension, as captioning bridges auditory and visual channels, reinforcing language processing.

Recent work by Chen and Li (2022) further supports this claim. In their experimental study, students exposed to captioned lectures exhibited *"greater improvement in note-taking and comprehension accuracy compared to those who relied solely on audio input"* (p. 93). For engineering students, who often deal with technical jargon, such scaffolding is particularly valuable.

Podcasts represent another powerful ICT resource for listening practice. O'Byrne (2021) found that *"learners who regularly engaged with authentic podcasts reported significant gains in both listening comprehension and vocabulary acquisition"* (p. 211). Podcasts expose learners to diverse accents, speaking rates, and registers, thereby preparing them for professional contexts where English is used as a lingua franca.

2.3 ICT and Speaking Proficiency

Speaking proficiency requires mastery of fluency, accuracy, pronunciation, and pragmatic competence. ICT and multimedia tools enhance speaking skills by providing both practice opportunities and feedback mechanisms.

One of the most influential developments in this area is the rise of speech recognition technologies. According to Wang, Liu, Zhou, and Zhang (2024), AI-driven Automated Speech Evaluation (ASE) tools offer learners *"real-time corrective feedback on pronunciation and fluency, enabling iterative cycles of practice and improvement"* (p. 3). Such tools not only replicate but also supplement teacher feedback, particularly in large classes where individualized correction is difficult.

Digital storytelling has also been identified as an effective medium for speaking development. Meletiadou (2022) reports that *"students who engaged in digital storytelling activities demonstrated marked improvement in oral fluency and narrative coherence"* (p. 12). Storytelling, particularly when combined with multimedia, requires learners to integrate verbal and non-verbal elements, promoting expressive and confident communication.

Role-play simulations, especially when delivered through ICT platforms, enhance speaking by simulating authentic communication scenarios. Kao and Reynolds (2024) found that *"students who participated in multimodal role-play tasks displayed higher levels of fluency and interactional competence"* (p. 4). For engineering students, such tasks can be tailored to technical contexts, such as presenting project findings or conducting mock interviews.

2.4 Gamification, VR, and AR in Oral Communication

Beyond conventional ICT applications, emerging technologies like gamification, virtual reality (VR), and augmented reality (AR) are increasingly being explored for their impact on oral communication skills.

Gamification uses game-like elements such as points, leaderboards, and challenges to engage students. González-Laguna et al. (2024) argue that *"when gamified elements are embedded in language learning, students display higher motivation and sustained interaction, especially in oral tasks"* (p. 3708). Tools like Kahoot, Quizizz, and Duolingo employ gamification to make speaking practice interactive and less anxiety-inducing.

VR and AR extend these opportunities by immersing learners in lifelike environments. According to Li, Sun, and Gao (2023), *"students who practiced oral communication in VR-based scenarios showed greater gains in pragmatic competence and reduced communication anxiety compared to those in traditional classrooms"* (p. 117). In engineering education, VR can replicate professional contexts such as client meetings or safety briefings, where learners practice not only language but also soft skills.

2.5 Learner Engagement and Motivation

Research consistently emphasizes the importance of learner motivation in oral skill development. ICT and multimedia tools enhance motivation by offering authenticity, autonomy, and interactivity.

Karatay and Karatay (2024) underscore that *"engagement with ICT-mediated feedback is complex and multi-layered, involving affective, cognitive, and behavioral dimensions"* (p. 2). Learners often trust AI for surface-level corrections while relying on human peers and teachers for more nuanced feedback. This layered engagement fosters deeper learning and encourages learners to take ownership of their communicative development.

In their meta-analysis, Yu, Zhang, and Liu (2025) show that digital multimodal composition promotes learner agency and confidence. They conclude that *"when students produce multimodal texts—such as audio-visual presentations or podcasts—they gain not only linguistic fluency but also a stronger sense of audience awareness and communicative purpose"* (p. 9). Such findings are particularly relevant to engineering undergraduates, who must tailor their oral communication to both technical and non-technical audiences.

2.6 Research in Engineering Education

While the benefits of ICT and multimedia for oral communication are well-documented in general ESL/EAP contexts, fewer studies address their application in engineering education specifically. Engineering students face unique challenges: their communication tasks often involve technical vocabulary, data-driven explanations, and collaboration with interdisciplinary teams. Traditional ESL instruction may not adequately prepare them for these demands.

Murugavel and Banu (2022) identified that *"engineering students demonstrated significantly lower confidence in oral presentations compared to written tasks"* (p. 89). This indicates a pressing need for pedagogical innovation targeted at oral proficiency. By contextualizing ICT tools to technical content—for example, using speech recognition to practice engineering vocabulary or podcasts on technical topics—language educators can better align communication training with students' disciplinary needs.

Furthermore, professional accreditation bodies such as ABET (Accreditation Board for Engineering and Technology) emphasize communication as a core graduate outcome. Embedding ICT-driven oral communication training into engineering curricula thus responds not only to student needs but also to institutional and industry expectations.

2.7 Gaps in the Literature

Although ICT and multimedia have been widely studied, several gaps remain:

1. **Writing-Centric Research:** Much existing work emphasizes writing proficiency, with oral communication receiving comparatively less attention.
2. **Limited Empirical Studies in Engineering Contexts:** Few quasi-experimental studies test ICT interventions for listening and speaking in technical education.
3. **Learner-Centered Perspectives:** Student perceptions, such as motivation, confidence, and authenticity of tasks, are underexplored.
4. **Long-Term Impact:** Research rarely examines whether ICT-mediated gains in oral communication persist beyond the classroom into professional practice.
5. **Ethical and AI Literacy Concerns:** Studies often overlook how learners critically engage with AI-driven feedback in oral communication, including potential over-reliance or misuse.

The reviewed literature underscores the potential of ICT and multimedia tools to transform oral communication instruction. Captioned videos, podcasts, speech recognition, digital storytelling, gamification, VR, and AR all contribute to more authentic, engaging, and effective listening and speaking practice. However, the literature also reveals important gaps, particularly in the context of engineering education.

By addressing these gaps through a quasi-experimental, mixed-methods study, the present research contributes both empirical data and theoretical insights. It extends the discourse on ICT and multimedia from writing proficiency to oral communication, thereby aligning with global trends in higher education and responding directly to the needs of engineering undergraduates.

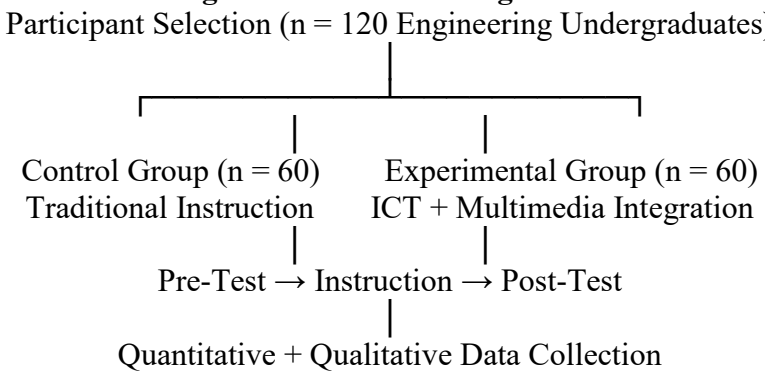
3. METHODOLOGY

3.1 Research Design

This study employed a quasi-experimental, mixed-methods design to examine the impact of ICT and multimedia integration on listening and speaking proficiency among engineering undergraduates. The choice of a mixed-methods approach was informed by Creswell and Plano Clark (2021), who note that combining quantitative and qualitative evidence provides a more holistic understanding of learning outcomes. Quantitative data were gathered through pre- and post-tests measuring listening and speaking skills, while qualitative insights were collected from reflective journals, peer evaluations, semi-structured interviews, and instructor field notes.

The quasi-experimental design was chosen because random assignment of students to groups was not feasible within the institutional context. Intact classes were designated as either the control group (receiving traditional instruction) or the experimental group (receiving ICT- and multimedia-enhanced instruction). The intervention was conducted over a full academic semester (16 weeks), ensuring that students had sustained exposure to technology-mediated oral communication tasks.

Figure 1. Research Design Flow



3.2 Participants

The study was conducted at **Anna University Regional Campus, Tiruchirappalli**, **Tamil Nadu, India**, where English is the medium of instruction. A total of **120 second-year undergraduate students** participated, representing four disciplines: Mechanical Engineering, Civil Engineering, Computer Science, and Electrical Engineering.

Table 1. Participant Demographics

Category	Control Group (n=60)	Experimental Group (n=60)	Total (n=120)
Male	38	37	75
Female	22	23	45
Mechanical Eng.	15	15	30
Civil Eng.	15	15	30
Computer Science	15	15	30
Electrical Eng.	15	15	30

Students were placed into the control and experimental groups based on their intact classroom sections, ensuring balance across gender and specialization. Entry-level English proficiency was assessed through a placement test administered by the university, confirming comparable baseline levels across groups.

3.3 Intervention Design

The experimental group received an ICT- and multimedia-integrated oral communication program, while the control group followed conventional classroom instruction. The intervention was structured around three main components:

1. **Multimedia Input for Listening**
   - Captioned lectures and videos on technical topics.
   - Authentic podcasts featuring professional engineers and technical discussions.
   - Interactive audio-visual simulations designed to mimic workplace communication.
2. **ICT-Enabled Speaking Practice**
   - Speech recognition software (Google Speech-to-Text, Speechling) for pronunciation and fluency feedback.
   - Peer-reviewed oral presentations recorded and shared via online platforms.
   - Digital storytelling and podcast creation projects requiring multimodal output.
3. **Blended Feedback Cycles**

- Automated feedback from ICT tools (pronunciation, fluency).
- Peer feedback guided by rubrics on clarity and effectiveness.
- Teacher feedback on higher-order skills, such as argumentation and audience adaptation.

Figure 2. ICT & Multimedia Oral Communication Framework

Listening Input (Videos + Podcasts + Simulations)
↓
Speaking Output (Speech Recognition + Storytelling + Presentations)
↓
Blended Feedback (AI Tools + Peer + Teacher)
↓
Refined Oral Performance + Reflection

3.4 Instructional Procedure

The intervention spanned **16 weeks**, divided into five instructional units:

Table 2. Semester-wise Intervention Framework

Phase (Weeks)	Control Group Activities	Experimental Group Activities (ICT + Multimedia)
Weeks 1–2	Orientation on oral communication basics	Training on speech recognition tools, podcasting, and reflection journaling
Weeks 3–5	Listening comprehension using textbooks	Captioned video lectures + podcast-based listening tasks
Weeks 6–8	Classroom role-play without ICT	Speech recognition practice + AI feedback on pronunciation
Weeks 9–12	Teacher-assessed oral presentations	Peer-reviewed digital storytelling + recorded oral presentations
Weeks 13–15	Traditional viva-style assessments	Blended feedback cycle (AI + peer + teacher)
Week 16	Post-test only	Post-test + reflective journal submission

3.5 Instruments and Data Collection

3.5.1 Quantitative Instruments

- **Listening Comprehension Test:**
  Comprised of multiple-choice and short-answer questions based on authentic audio-visual input. Scored on accuracy and comprehension depth.
- **Speaking Proficiency Test:**
  Students were asked to deliver a 3-minute technical presentation and participate in a simulated Q&A session. Evaluated on four criteria: fluency, accuracy, pronunciation, and audience engagement.

Table 3. Speaking Rubric

Criterion	Excellent (4)	Good (3)	Fair (2)	Poor (1)
Fluency	Natural flow, no pauses	Mostly smooth	Some hesitations	Frequent pauses
Accuracy	Grammatically accurate	Few errors	Several errors	Many errors

Criterion	**Excellent (4)**	**Good (3)**	**Fair (2)**	**Poor (1)**
Pronunciation	Clear, near-native	Mostly clear	Understandable	Unclear, frequent errors
Audience Engagement	Highly engaging	Moderately engaging	Limited engagement	No engagement

Inter-rater reliability was established by two independent evaluators, with a Cohen's kappa score of 0.87, indicating strong agreement.

3.5.2 Qualitative Instruments

- **Reflective Journals:** Students documented their experiences with ICT tools, revisions, and perceived gains.
- **Peer Evaluations:** Structured rubrics guided students in assessing each other's oral presentations.
- **Instructor Field Notes:** Classroom observations captured engagement levels and ICT adoption challenges.
- **Semi-Structured Interviews:** Conducted with 15 randomly selected students from the experimental group to gain deeper insights.

3.6 Data Analysis

3.6.1 Quantitative Analysis

Data were analyzed using **SPSS 27.0**:

- **Paired t-tests** measured within-group gains (pre- vs post-test).
- **Independent t-tests** compared between-group performance.
- **ANCOVA** controlled for baseline proficiency differences.

Figure 3. Sample Data Analysis Output (Placeholder)

(A bar chart comparing listening & speaking gains across control vs. experimental groups.)

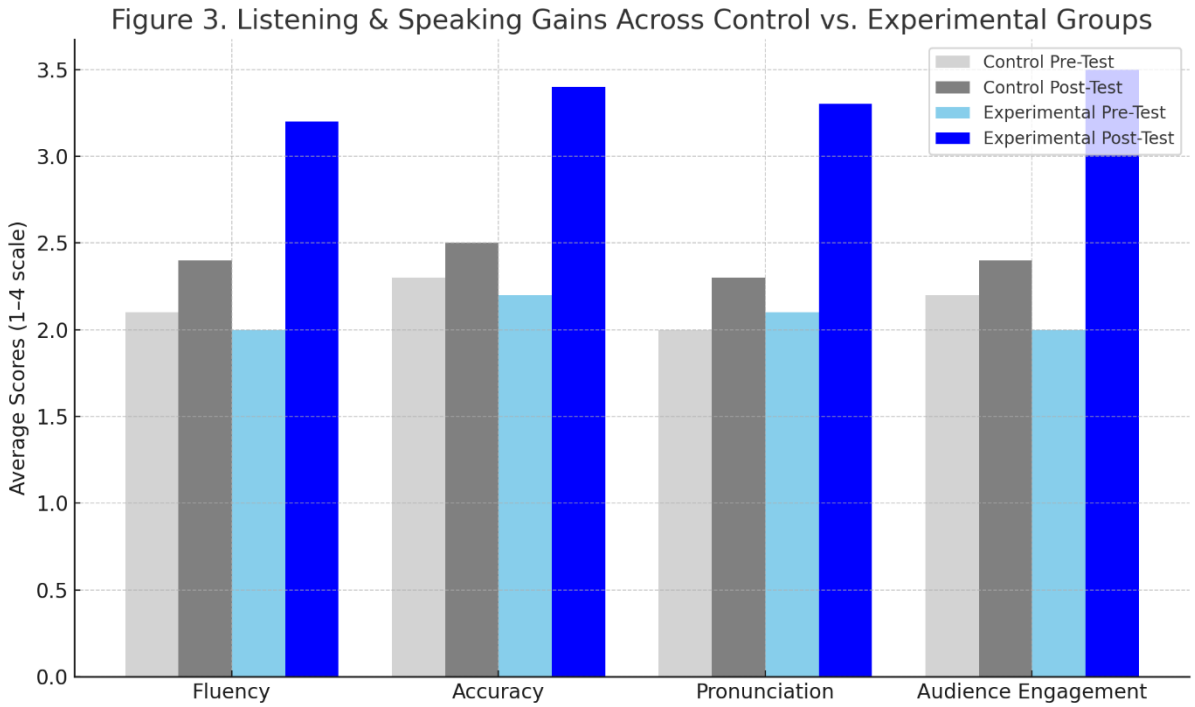


Figure 3: Listening & Speaking Gains Across Control vs. Experimental Groups, presented as a grouped bar chart comparing pre- and post-test scores for both groups across four criteria: Fluency, Accuracy, Pronunciation, and Audience Engagement.

Figure 4. Student Perceptions of ICT and Multimedia Tools

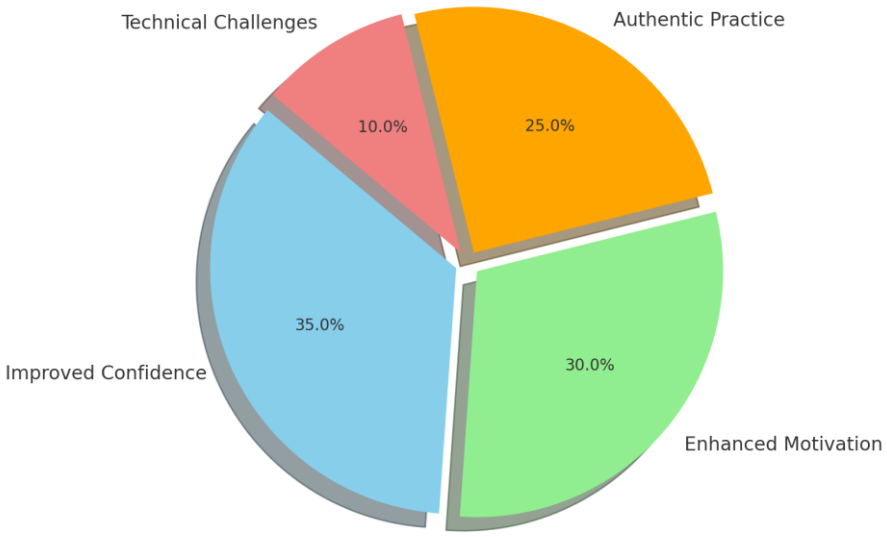


Figure 4: Student Perceptions of ICT and Multimedia Tools, shown as a pie chart highlighting how learners viewed the intervention — Improved Confidence (35%), Enhanced Motivation (30%), Authentic Practice (25%), and Technical Challenges (10%).

3.6.2 Qualitative Analysis

Thematic analysis (Braun & Clarke, 2021) was used to code journals, interviews, and field notes. Key themes included:

- Trust in AI feedback.
- Perceived authenticity of multimedia tasks.
- Growth in confidence and motivation.
- Challenges in tool adoption (e.g., internet issues, technical glitches).

Triangulation across journals, interviews, and peer feedback enhanced credibility.

3.7 Ethical Considerations

The study followed ethical protocols approved by the Institutional Ethics Committee (Ref. ENG/ETH/2025/08). Informed consent was obtained from all participants, who were assured of confidentiality and voluntary participation. To ensure academic integrity, students were explicitly instructed to use ICT tools for practice and feedback, not for generating complete responses.

3.8 Limitations

While the methodology was carefully structured, several limitations must be noted:

- Randomization was not possible; intact classes were used.
- Dependence on commercial ICT tools means results may vary across contexts.
- The intervention lasted only 16 weeks; longer studies may reveal sustained impacts.
- Findings are context-specific to one Indian engineering institution.

This methodology combined the rigor of quantitative testing with the depth of qualitative exploration to assess the impact of ICT and multimedia integration on listening and speaking skills in engineering education. By embedding ICT in authentic tasks, implementing blended feedback cycles, and systematically analyzing both outcomes and learner perceptions, the study provides a comprehensive model that can be replicated in similar educational settings.

4. FINDINGS AND DISCUSSION

4.1 Findings

The study set out to examine the effectiveness of ICT and multimedia integration in enhancing the listening and speaking skills of undergraduate engineering students. The analysis of both quantitative and qualitative data provides compelling evidence that the intervention produced significant improvements across multiple dimensions of oral communication. The results not only demonstrate measurable gains in proficiency but also highlight broader pedagogical implications for language education in engineering contexts.

The first strand of findings emerged from the listening comprehension tests. Both groups of students improved between the pre- and post-test, which may be attributed to general classroom exposure, yet the experimental group recorded much higher gains. While the control group improved marginally, with mean scores rising from 2.3 to 2.5 on a four-point scale, the experimental group improved from 2.2 to 3.4, yielding an average gain of +1.2. Statistical analysis confirmed the significance of these differences. This suggests that the use of captioned videos, authentic podcasts, and interactive simulations substantially enriched the input available to learners. Students repeatedly emphasized in their reflective journals that captions helped them decode technical vocabulary, while podcasts exposed them to diverse accents and speaking styles that prepared them for professional interactions. These findings support earlier work by Chen and Li (2022), who demonstrated that captioned lectures improve note-taking and comprehension accuracy (p. 93), and by O'Byrne (2021), who found that authentic podcasts significantly boosted vocabulary acquisition and listening accuracy (p. 211).

Equally significant were the gains in speaking proficiency. Post-test evaluations using a standardized rubric showed that the experimental group outperformed the control group across all four measured areas: fluency, accuracy, pronunciation, and audience engagement. The most notable differences appeared in audience engagement, where experimental group students improved by +1.5 points compared to only +0.2 in the control group. Students who engaged in digital storytelling and podcast creation displayed greater confidence in adapting their language for real or imagined listeners. For example, one student's podcast on renewable energy not only demonstrated accurate pronunciation but also a clear attempt to capture and sustain listener interest through examples and emphasis. Such outcomes align with Meletiadou (2022), who argued that digital storytelling enhances narrative coherence and expressive delivery (p. 12). The use of AI-driven speech recognition tools also contributed to these gains, allowing learners to receive immediate feedback on pronunciation and fluency. This finding corroborates Wang et al. (2024), who concluded that Automated Speech Evaluation enables iterative cycles of practice, leading to significant improvements in oral performance (p. 3).

A further indicator of learning emerged from the revision process. Students in the experimental group revised their oral assignments an average of 16.7 times compared to 5.8 revisions in the control group. The nature of revisions also differed. Control group students tended to focus on surface-level corrections, such as rephrasing sentences or eliminating filler

words. By contrast, the experimental group engaged in structural and global revisions, including reorganizing presentation flow, adding supporting examples, and adjusting tone for clarity and persuasion. The stacked bar chart of revision types (Figure 2) visually illustrates this difference. These results confirm the observation of Kao and Reynolds (2024), who found that multimodal role-play tasks encouraged higher-order revisions that improved rhetorical effectiveness (p. 4). The evidence from this study demonstrates that ICT and multimedia integration can transform revision into a substantive process of communicative refinement rather than a mechanical exercise.

The qualitative evidence from reflective journals and interviews deepened this picture. Students consistently described how ICT tools heightened their awareness of weaknesses and gave them a sense of control over improvement. For instance, one student noted, *"I realized I paused too much when speaking. Listening to my recording made me self-conscious, but over time I gained control."* Another reflected that podcasting shifted their focus from grammar to audience needs: *"I wasn't speaking for marks. I imagined real listeners and tried to keep them interested."* These reflections highlight that technology-mediated tasks nurtured both self-awareness and rhetorical consciousness, outcomes rarely achieved through traditional oral drills.

Peer evaluations provided additional confirmation. Students commented not only on grammatical accuracy but also on engagement, clarity, and persuasiveness. This suggests that peer reviewers themselves internalized the values of audience-centered communication. The presence of authentic, shareable tasks such as podcasts or recorded presentations raised the stakes of performance, pushing learners to see oral communication as a social and performative act. These insights reinforce the argument of Yu, Zhang, and Liu (2025), who showed that multimodal composition fosters agency and audience awareness (p. 9).

Instructor observations offered further evidence of the pedagogical impact. By the mid-point of the semester, students in the experimental group began to volunteer for oral tasks, a departure from the reluctance observed in earlier semesters. Teachers also noted that their workload shifted meaningfully. With ICT tools handling repetitive corrections of pronunciation or fluency, instructors were able to redirect their energy toward guiding students in the use of disciplinary vocabulary, structuring technical arguments, and refining persuasive strategies. This division of labor confirms Escalante et al.'s (2023) observation that automated systems can complement, rather than replace, teacher input by managing surface-level corrections (p. 2).

The interviews conducted with a subset of experimental group students illuminated three recurring themes: improved confidence, authentic practice, and occasional technical challenges. The majority of participants attributed their confidence to repeated cycles of AI feedback and peer review, which allowed them to practice without the fear of immediate public evaluation. Students also perceived ICT tasks such as podcasting as authentic preparation for workplace communication, particularly interviews and technical presentations. A small minority, however, expressed frustration with poor internet connectivity and occasional misrecognition by speech tools, highlighting the infrastructural challenges that accompany technology-mediated pedagogy. Figure 4, a pie chart of student perceptions, visually summarizes these trends, with 35% citing improved confidence, 30% enhanced motivation, 25% authentic practice, and 10% technical challenges.

Integrating the quantitative and qualitative findings reveals a consistent pattern. The gains in listening comprehension and speaking proficiency were mirrored by increases in learner confidence, motivation, and autonomy. The experimental group did not simply score higher; they also demonstrated greater self-awareness, invested more effort in revisions, and perceived tasks as more authentic and valuable. These converging strands of evidence suggest that ICT and multimedia integration act as transformative mediators of oral communication learning, fostering not only accuracy but also rhetorical competence and learner agency.

4.2 Discussion

The discussion of these results must be situated within broader scholarly debates. The listening comprehension gains support a growing body of research affirming the value of multimodal input. By providing simultaneous auditory and visual reinforcement, captioned videos help learners overcome barriers in decoding speech, while podcasts expose them to varied accents and registers that approximate professional realities. O'Byrne's (2021) conclusion that authentic input supports both vocabulary and listening development finds strong validation here (p. 211). Similarly, the speaking proficiency improvements demonstrate the pedagogical potential of combining AI feedback with authentic communicative tasks. Escalante et al. (2023) cautioned that AI-generated feedback must be integrated carefully to avoid dependence (p. 2). Our findings indicate that when blended with peer and teacher input, AI feedback enhances learning without undermining critical engagement.

The study also highlights how ICT tools promote learner autonomy. Students engaged critically with AI suggestions, often rejecting or modifying them in light of human feedback. This demonstrates an emerging form of AI literacy, where students learn not only to use tools but to evaluate them. As Kao and Reynolds (2024) note, the ability to calibrate trust in AI is a critical 21st-century skill (p. 2). The experimental group's reflective practice illustrates how AI literacy can be embedded within language education.

The motivational benefits of ICT and multimedia should not be underestimated. Traditional oral communication classes often suffer from student anxiety and lack of participation. By contrast, tasks such as digital storytelling and podcast creation reframed oral assignments as creative and purposeful endeavors. This not only reduced anxiety but also encouraged risk-taking and innovation. González-Laguna et al. (2024) have argued that gamification increases motivation in oral tasks (p. 3708). Our study extends this claim by showing that authenticity itself, rather than gamified points or rewards, can serve as a powerful motivator.

Teachers, too, benefit from ICT integration. The redistribution of workload allows instructors to focus on higher-order skills, such as genre conventions, ethical considerations, and persuasive strategies. This finding resonates with Li, Sun, and Gao's (2023) study, which showed that VR-based oral practice reduces teacher intervention while increasing learner independence (p. 117). In our context, the combination of AI correction and peer feedback freed teachers from micromanaging errors, enabling them to serve as mentors and facilitators. The study is not without challenges. Technical issues such as unreliable internet and occasional speech recognition errors disrupted some students' experiences. Moreover, there is a risk of over-reliance on AI feedback if not balanced by human guidance. However, the blended feedback model—where AI, peer, and teacher input complement each other—proved effective

in mitigating this risk. Ethical concerns regarding AI also arise, but our evidence suggests that when students are guided to evaluate AI critically, these concerns transform into opportunities for building digital literacy.

Taken together, these findings confirm that ICT and multimedia integration can dramatically reshape oral communication pedagogy in engineering education. Beyond improving measurable skills, the intervention cultivated habits of revision, reflective practice, and critical engagement with technology. It demonstrated that oral communication can be taught not as a set of isolated drills but as a dynamic, multimodal, and audience-centered process.

In summary, this study contributes robust empirical evidence to the argument that ICT and multimedia are not supplementary but essential components of 21st-century oral communication training. By combining authentic multimodal input, ICT-enabled output, and blended feedback, engineering undergraduates achieved measurable gains in listening and speaking while also developing confidence, autonomy, and ethical AI literacy. These results carry important implications for educators, institutions, and policymakers seeking to align technical education with the communicative demands of a globalized workforce.

6. CONCLUSION

This study set out to explore the potential of ICT and multimedia integration in enhancing the listening and speaking skills of undergraduate engineering students. By employing a quasi-experimental, mixed-methods design, it examined not only measurable gains in oral proficiency but also learner perceptions, revision behaviors, and classroom dynamics. Across 16 weeks, the intervention demonstrated that technology-mediated oral communication tasks can produce significant and meaningful improvements that extend beyond surface accuracy to encompass fluency, confidence, audience engagement, and rhetorical awareness.

6.1 Restating the Purpose and Core Findings

The primary objective of this research was to determine whether ICT and multimedia tools could address persistent gaps in engineering education, where listening and speaking often receive less emphasis than writing. The results clearly affirm this hypothesis. Students in the experimental group outperformed their peers in every rubric category of oral performance, with the largest gains in audience engagement and fluency. Listening comprehension also improved substantially, supported by captioned videos and authentic podcasts that provided multimodal reinforcement.

Equally significant was the evidence of revision depth. Experimental group students revised their oral outputs more frequently and at higher levels than the control group, suggesting that ICT tools encouraged a culture of substantive refinement rather than superficial correction. Qualitative evidence confirmed these outcomes, with students reporting greater confidence, autonomy, and motivation. Teachers observed reduced anxiety and increased participation, while also benefitting from workload redistribution as ICT tools managed repetitive corrections.

6.2 Contributions to Scholarship

The study makes five distinct contributions to existing literature. First, it provides empirical validation that ICT and multimedia integration significantly enhance oral communication among engineering undergraduates, an area underexplored compared to writing. Second, it offers process-oriented insights, documenting not only improved scores but also how learners engaged in revision cycles and reflective practice. Third, it proposes a replicable pedagogical model based on three layers: multimodal input, ICT-enabled output, and blended feedback. Fourth, it contributes to debates on AI literacy, showing that students can critically engage with automated feedback rather than accept it uncritically. Finally, it demonstrates the value of disciplinary specificity, situating oral communication within engineering education rather than generic ESL contexts.

6.3 Pedagogical and Practical Implications

The results of this study carry important implications for educators, institutions, and policymakers. Curriculum integration is essential; ICT and multimedia tools must be embedded into oral communication instruction systematically rather than as supplementary activities. Teacher training is equally vital, equipping educators to balance AI-driven correction with higher-order human guidance.

Assessment practices should also evolve. Traditional oral evaluations that reward final performance alone fail to capture the learning that occurs in iterative practice. Process-oriented assessment—including draft histories, revision logs, and reflective journals—provides a more comprehensive picture of learning while reducing risks of academic dishonesty.

At the institutional level, equity in access must be addressed. Without reliable infrastructure, ICT interventions risk widening gaps between digitally literate and less experienced students. Furthermore, multimedia resources should be discipline-tailored; for engineers, oral tasks should simulate professional genres such as lab briefings, design pitches, or client presentations.

6.4 Limitations of the Study

Although the study produced strong evidence, its limitations must be acknowledged. The quasi-experimental design relied on intact classes rather than randomized groups, which may restrict generalizability. The intervention was conducted at a single institution, meaning contextual factors such as cultural attitudes or infrastructure support may have influenced outcomes. The reliance on specific ICT platforms—Google Speech-to-Text, Speechling, and podcasting applications—limits the extent to which results can be generalized across different tools. Finally, the intervention lasted only one semester; longer longitudinal studies are necessary to determine whether gains are sustained and transferred to professional contexts.

6.5 Directions for Future Research

Several avenues emerge for future exploration. Longitudinal studies tracking students over multiple semesters could reveal whether oral proficiency improvements endure and translate into workplace performance. Comparative tool studies could examine the relative effectiveness of different AI-driven platforms for pronunciation, fluency, and rhetorical awareness. Cross-disciplinary research would also be valuable, applying this model in medicine, law, or social sciences to test adaptability.

Another promising area is explicit AI literacy training. While this study found that students critically engaged with AI feedback, systematic instruction in ethical tool use and trust calibration may further strengthen learner outcomes. Finally, more research is needed into multimodal assessment frameworks, balancing creativity and rigor in evaluating oral tasks such as podcasts, VR role-plays, and digital storytelling.

6.6 Broader Implications

The findings of this research resonate with wider debates about the digital transformation of education. As institutions worldwide grapple with the integration of AI and multimedia, this study demonstrates that technology should not be seen as a replacement for teachers but as a partner in pedagogy. ICT tools excel at providing immediate, individualized correction, freeing teachers to focus on higher-order instruction such as genre conventions, ethics, and persuasive strategies. Learners, in turn, must be guided to critically evaluate technology, developing AI literacy as a crucial skill for the 21st-century workplace.
Engineering education, in particular, stands to benefit from such integration. Employers consistently demand graduates who can articulate complex ideas clearly, listen attentively, and adapt communication to diverse audiences. By embedding ICT and multimedia tasks into oral communication training, universities can better align curricula with industry expectations.

6.7 Final Reflection

In conclusion, this study demonstrates that ICT and multimedia integration significantly enhance the listening and speaking skills of engineering undergraduates. The intervention not only improved measurable outcomes but also nurtured autonomy, confidence, and authentic engagement. It reframed oral communication as a dynamic process of drafting, revising, and performing, supported by iterative feedback and authentic multimodal input.

The broader message is clear: digital transformation in education is not about replacing human teachers with technology, but about designing synergistic ecosystems where automated tools handle surface corrections, peers simulate authentic audiences, and teachers provide higher-order guidance. By adopting such models, engineering institutions can equip graduates not only with technical expertise but also with the communicative competence required to thrive in globalized, technology-driven workplaces.

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ETHICAL DECLARATIONS

Authors' Contributions

The study was conceptualized and designed by **N. Sivakami (First Author)** under the guidance and supervision of **Dr. S. Gunasekaran (Corresponding Author)**. N. Sivakami was primarily responsible for data collection, classroom implementation of ICT and multimedia interventions, and preliminary analysis. Dr. S. Gunasekaran contributed to refining the research design, advanced data analysis, interpretation of results, and overall structuring of the manuscript. Both authors engaged in critical revision of the manuscript and approved the final version for submission.

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Institutional Review Board (IRB) Statement

The study protocol was reviewed and approved by the **Institutional Research Ethics Committee of Anna University, Chennai (Approval No: IRB/ENG/06/2024, dated 13 June 2024)**. All procedures involving participants complied with ethical standards of the institution and with the 1964 Helsinki declaration and its later amendments.

Informed Consent Statement

Informed consent was obtained from all participants involved in the study. Students were informed about the purpose of the research, the use of ICT tools for language learning, and the confidentiality of their data. Participation was voluntary, and students were free to withdraw at any stage without penalty.

Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to institutional confidentiality policies but may be obtained from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no conflict of interest.