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AI-Powered Text-to-Speech Technology: An Experimental Study Using Krashen's I+1 Input Hypothesis to Improve Responsive Listening Skills in First-Year Engineering Students

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This study, guided by Krashen's Input Hypothesis, investigates the effect of a technology-based intervention on improving responsive listening skills among first-year engineering students. Seventy students were divided equally into experimental and control groups. The experimental group received audio materials developed from engineering-focused podcasts, featuring formats like direct interviews and dialogues designed to align with Krashen's i+1 principle, ensuring content was slightly beyond the student's current comprehension levels. These materials emphasized real-world application and student engagement by simulating authentic engineering scenarios, such as professional discussions and problem-solving tasks. The audio recordings were produced using the Natural Readers application, while the control group received no intervention. Responsive listening skills were assessed at pre- and post-intervention stages through tasks such as fill-in-the-blanks, sequence arrangement, and short-answer responses, with scoring based on the accuracy of responses. A paired samples t-test revealed significant improvement within the experimental group, while the control group showed no significant change. An independent samples t-test further demonstrated that the experimental group significantly outperformed the control group, achieving a mean score of 20.40 compared to 15.55, significant at the 1% level. These findings confirm the efficacy of the intervention in enhancing responsive listening skills and highlight the potential of AI-driven tools and contextualized materials to transform domain-specific language education.

Keywords: Listening Skill, Technology-based intervention, Krashen's Input Hypothesis and AI-Generated Audio Materials.

1. Introduction

The ability to listen responsively is fundamental for effective communication, particularly in fields that require precise understanding and immediate application of information, such as engineering. Responsive listening, characterized by the ability to comprehend, interpret, and react appropriately to spoken input, plays a critical role in the academic and professional success of engineering students. Despite its significance, listening often remains an underexplored area in language education, particularly in technical and domain-specific contexts. First-year engineering students face unique challenges in mastering responsive listening skills, as they must navigate complex technical language, unfamiliar jargon, and collaborative scenarios that demand active participation and real-time decision-making.

The theoretical framework guiding this study is Krashen's Input Hypothesis, which posits that language acquisition occurs most effectively when learners are exposed to input slightly beyond their current level of comprehension, a concept referred to as i+1. This principle has been widely recognized as a cornerstone of second-language acquisition, yet its application to domain-specific language learning, such as in engineering, is relatively underexplored. Responsive listening, in particular, aligns closely with the i+1 concept, as it requires learners to engage with spoken input that challenges their comprehension while providing meaningful opportunities for cognitive engagement.

The growing integration of technology in education presents new opportunities to address these challenges. AI tools, such as the Natural Readers application, offer innovative ways to create tailored audio materials that can enhance language learning experiences. Podcasts, in particular, have gained popularity as educational resources due to their conversational style and versatility. They provide learners with authentic, real-world content that can be adapted to suit various learning objectives and proficiency levels. Engineering-focused podcasts, for example, can simulate professional scenarios such as team discussions, client meetings, and technical presentations, making them a valuable resource for developing responsive listening skills in this domain.

Despite the potential of AI and podcast-based learning materials, research on their effectiveness in improving domain-specific listening skills remains limited. While previous studies have examined the role of comprehensible input in language acquisition, few have explored its impact on specialized contexts like engineering. Moreover, there is a lack of empirical evidence on how such interventions influence not only comprehension but also the ability to respond effectively in real-time communication scenarios.

This study seeks to bridge these gaps by evaluating the impact of a technology-based intervention, guided by Krashen's Input Hypothesis, on the responsive listening skills of first-year engineering students. By utilizing engineering-focused podcasts transformed into interactive formats, such as interviews and dialogues, this research aims to provide both theoretical and practical insights. Specifically, it explores how contextualized, AI-generated materials can enhance responsive listening skills and offer scalable solutions for language education in technical fields. The findings are expected to contribute to the growing body of knowledge on the integration of technology in language learning and to highlight the value of domain-specific approaches for improving communication skills.

2. Literature Review

Responsive listening is a vital skill in language learning, particularly in technical and professional fields where comprehension and real-time interaction are essential. This literature review explores the intersection of responsive listening, Krashen's Input Hypothesis, and the role of technology in enhancing language acquisition. While Krashen's Input Hypothesis provides a well-established framework for understanding how learners acquire language through comprehensible input, its application to domain-specific contexts, such as engineering, remains underexplored. Additionally, with the increasing integration of AI tools and podcasts in education, there is a need to evaluate their effectiveness in developing listening skills tailored to professional scenarios. This review aims to establish the theoretical and practical foundations for the current study by examining existing research and identifying gaps in the literature.

2.1 Krashen's Input Hypothesis

Krashen's Input Hypothesis, a cornerstone of his Second Language Acquisition (SLA) theory, emphasizes the importance of comprehensible input (CI) for effective language learning. The principle of i+1 posits that learners acquire language most effectively when exposed to input slightly beyond their current proficiency level, enabling them to expand upon their existing knowledge while remaining engaged and challenged (Krashen, 1985). This approach underscores the value of providing linguistically meaningful input that is incrementally advanced and contextually relevant.

The hypothesis has been widely applied across language domains, particularly in listening comprehension. Listening is regarded as both a foundational skill and a prerequisite for developing other language abilities, such as speaking, reading, and writing (Krahnke, 1985; Li, 2013). As learners are exposed to natural language use and authentic speech, listening facilitates the acquisition of vocabulary, syntax, and grammar in real-time contexts (Krashen, 1985). This highlights the importance of introducing learners to diverse and challenging auditory input to foster effective language acquisition.

2.2 Implementing the Input Hypothesis in Listening Skill Development

Numerous studies demonstrate the practical application of the Input Hypothesis in improving listening skills. Li (2013) investigated the integration of comprehensible input into college English listening courses in China. The findings revealed that exposing students to slightly challenging input enhanced their comprehension and engagement. Such input enabled learners to internalize complex language structures and acquire advanced vocabulary more effectively.

Similarly, Xiong (2019) examined the use of culturally relevant materials in English listening courses. The study found that adhering to i+1 principles significantly improved students' listening comprehension, especially when the materials included narratives and dialogues that reflected real-world scenarios. This aligns with Krashen's emphasis on meaningful and contextually engaging input as a cornerstone for language acquisition.

Kasimo et al. (2024) further emphasized the role of strategic listening techniques, such as summarizing and inferencing, in conjunction with i+1-based input. Their research demonstrated that combining these strategies with incrementally challenging auditory materials allowed learners to bridge gaps between their current and target language proficiency

levels.

2.3 Challenges and Opportunities in Applying Krashen's Hypothesis

Despite its numerous benefits, implementing the Input Hypothesis poses challenges. One key concern is ensuring the optimal difficulty of input (i+1) for learners with varying proficiency levels (Kasimo et al., 2024). Additionally, the absence of immediate feedback in traditional input-based activities can limit learners' ability to recognize and rectify errors (Krahnke, 1985). However, advancements in AI technology offer promising solutions, as AI-driven tools can dynamically adjust input complexity to suit individual learner needs (Li, 2013). These tools also provide opportunities for integrating adaptive and interactive auditory content to enhance learning outcomes.

1. Responsive Listening

Responsive listening is the active process of understanding and responding to spoken communication through meaningful verbal and non-verbal feedback. This skill, characterized by engagement, comprehension, and interaction, is essential in educational and professional contexts, particularly where collaboration and real-time feedback are critical. According to Pikor (1993), responsive listening differs from passive listening by requiring a two-way engagement, involving cues such as paraphrasing, questioning, or providing affirmations. This interaction fosters a deeper understanding and enhances mutual dialogue in dynamic scenarios.

2. The Role of Psycholinguistic Processes

Responsive listening relies on both bottom-up and top-down processes. Bottom-up processing focuses on decoding individual sounds, words, and sentences, while top-down processing integrates background knowledge and situational cues to construct meaning. Callahan (2011) explains that these processes are simultaneous and interactive in responsive listening, as listeners must decode auditory input while formulating contextually relevant responses. This dual engagement is vital for tasks requiring real-time interaction, such as classroom discussions or professional meetings.

3. Significance in Educational Contexts

Responsive listening plays a crucial role in enhancing students' critical thinking and communication skills. Denston (2021) notes that teachers who engage in responsive listening can create more inclusive and participatory classrooms, where learners feel heard and valued. Such practices encourage students to articulate their thoughts, respond to peers constructively, and build confidence in their communicative abilities. In professional education, such as engineering, responsive listening is critical for tasks involving technical discussions, team collaboration, and problem-solving.

4. Technological Applications

The integration of technology has expanded the potential for developing responsive listening skills. Gillies et al. (2019) demonstrated that AI-driven platforms could simulate responsive listening behaviors, such as backchannel cues, in virtual learning environments. These systems allow learners to practice interactive listening skills in realistic, controlled settings. Podcasts, as highlighted by Xiong (2019), offer another effective medium for fostering responsive listening. By presenting real-world conversational scenarios, podcasts provide learners with

opportunities to practice responding to authentic input, making them particularly valuable in domain-specific contexts like engineering.

5. Challenges and Opportunities

Teaching responsive listening presents unique challenges, such as addressing cultural differences and designing tasks that reflect real-world interaction. Barns (2019) emphasized that multicultural classrooms require tailored approaches to accommodate diverse communication styles and preferences. Furthermore, traditional listening tasks often lack interactivity, limiting learners' ability to practice real-time engagement. However, AI and adaptive learning technologies offer promising solutions by tailoring input to learners' proficiency levels and providing dynamic feedback.

6. Relevance to Current Research

This study builds on these insights by addressing the specific responsive listening needs of engineering students. By incorporating engineering-focused podcasts and interactive scenarios, the intervention aligns with research advocating for contextualized and interactive input. This approach not only enhances comprehension but also equips learners with the practical communication skills needed for professional success in technical domains.

2.4 Role of Natural Reader in Developing Responsive Listening Skills

The integration of Artificial Intelligence (AI) in language learning has paved the way for transformative tools, such as NaturalReader, to enhance listening and responsive listening skills. NaturalReader, an advanced Text-to-Speech (TTS) tool, converts written text into lifelike audio and offers customizable features like voice modulation, speed adjustment, and accent variation. These capabilities make it particularly effective in fostering listening comprehension and real-time interaction, aligning directly with Krashen's i+1 hypothesis, which emphasizes exposure to slightly challenging input to promote language acquisition.

1) Natural Reader and Responsive Listening

Responsive listening is a dynamic skill that involves not only understanding spoken input but also responding appropriately through verbal and non-verbal cues. Tools like NaturalReader play a crucial role in developing this skill by simulating real-world conversational scenarios. According to Fitria (2023), NaturalReader's ability to generate contextualized and professional dialogues, such as interviews and team-based discussions, allows learners to practice active listening and real-time feedback in controlled settings.

- Simulating Professional Contexts: Natural Reader can create engineering-specific audio materials, such as collaborative brainstorming sessions or client presentations, to help learners develop precision in their responses.

- Reinforcing Contextual Understanding: By tailoring input to domain-specific terminologies and scenarios, the tool ensures that learners acquire both linguistic and technical comprehension, critical for engineering students.

2) Broader Applications in Responsive Listening

NaturalReader is particularly effective in creating interactive listening environments where

learners can:

- Engage with Authentic Content: As highlighted by Vandergrift and Goh (2012), strategic listening tasks such as predicting, clarifying, and summarizing are vital for developing responsive listening skills. Natural Reader provides a platform for practicing these strategies with authentic and contextually relevant content.

- Adapt to Diverse Accents: Exposure to various accents and speech patterns helps learners improve their ability to comprehend global English, essential for professional communication in multicultural settings.

3) Domain-Specific Advantages in Engineering Education

Engineering education often involves complex communication scenarios that demand precise comprehension and interaction. The following applications of NaturalReader align with these requirements:

- Technical Discussions: Simulating team discussions or technical reviews where learners must listen, synthesize, and provide informed responses.

- Presentations and Pitches: Preparing students for client presentations by exposing them to structured, formal speech generated by Natural Reader.

- Problem-Solving Scenarios: Facilitating critical listening exercises where learners analyze information from dialogues and respond with solutions.

By bridging the gap between theoretical instruction and real-world application, NaturalReader equips engineering students with the responsive listening skills required for their professional success.

4) AI-Driven Benefits

- Customization:NaturalReader's flexible features allow educators to tailor content to specific learner needs, including speech speed, pitch, and vocabulary complexity (Fitria, 2023).

- Accessibility: Its low-cost and scalable nature make it an ideal solution for institutions with limited resources.

- Engagement: The tool's lifelike audio generation fosters learner motivation by creating immersive and relatable listening experiences.

5) Challenges in Integration

Despite its advantages, integrating NaturalReader into responsive listening tasks presents challenges:

- Artificial Speech Limitations: Learners may perceive synthetic voices as less engaging than human recordings, though advancements in AI have reduced this gap (Andriani et al., 2018).

- Technical Dependencies: Reliable internet and device compatibility are essential for effective implementation, which can be barriers in under-resourced areas.

This study uniquely contributes to existing research by utilizing NaturalReader to develop responsive listening skills in engineering students. By incorporating engineering-specific terminologies and scenarios, the study demonstrates how NaturalReader can transform generic TTS applications into domain-specific learning tools. This approach not only enhances listening comprehension but also prepares students for real-world professional interactions, bridging a critical gap in existing language education methodologies.

Hypotheses of the Study

- $H_0$1: There is no significant improvement in Technology-Based Intervention for Responsive listening among first-year Engineering students
- $H_0$2: There is no significant improvement from pre to post-stages with respect to Responsive listening Skills among first-year Engineering students in the Control group.
- $H_0$3: There is no significant difference between the Experimental and Control group before giving intervention for Responsive listening among first-year Engineering students.
- $H_0$4: There is no significant difference between Experimental and Control group after giving intervention for Responsive listening among first year Engineering students

3 Methodology

3.1 Research Design

This study followed a quasi-experimental design to examine the effects of a technology-based intervention on improving responsive listening skills among first-year engineering students. he materials were designed to align with Krashen's i+1 principle, providing input slightly beyond the learners' proficiency levels.

To ensure a meaningful comparison, students were divided into two groups: an experimental group, which received the intervention, and a control group, which continued with their standard curriculum.

3.2 Participants

Seventy first-year engineering students from a reputed Deemed University in India participated in this study. The students were divided equally into two groups: the experimental group (n = 35), which received the tailored intervention, and the control group (n = 35), which continued with their usual academic routine without additional input. All participants were selected from two intact classes within the same institution, ensuring that the groups shared similar backgrounds in terms of age, academic experience, and English proficiency. Notably, all the students had been educated in English as the medium of instruction since their primary level of schooling, ensuring a consistent linguistic foundation. This homogeneity among the participants minimized variability and strengthened the comparability of the results, making it possible to focus on the effects of the intervention.

3.3 Intervention Material

The audio materials for this intervention were specifically developed to enhance the responsive

listening skills of first-year engineering students, with a focus on preparing them for real-world professional communication. To achieve this, the content was carefully selected and adapted from a range of engineering-focused podcasts and historically significant topics. Key sources included To the Moon and Beyond 1: What We Learned from Landing on the Moon and Why We Stopped Going, The Engineering Student Experience Podcast - What's It Like to Start a Start-Up?, and The Engineering Student Experience Podcast - Being an Engineering Student in the Time of COVID-19. Additionally, a segment highlighting the significance of Bletchley Park—the birthplace of British codebreaking and modern information technologywas incorporated. This segment emphasized the pivotal role Bletchley Park played during World War II, uncovering critical intelligence on enemy strategies, which ultimately influenced the war's outcome.

To make the content relatable and engaging, it was restructured into imaginative formats, including interviews, dialogues, and collaborative discussions. These formats mirrored professional scenarios, such as team brainstorming sessions or technical discussions, helping students practice listening in contexts they are likely to encounter in their careers. The finalized scripts were then transformed into audio recordings using NaturalReader, an AI-powered Text-to-Speech tool, ensuring consistency, accessibility, and a high-quality auditory experience.

The intervention was conducted in a language lab equipped with high-quality headphones, creating an immersive environment for the learners. This setup enabled students to concentrate fully on the audio input, free from external distractions and provided an optimal setting for developing their responsive listening skills.

3.4 Intervention Procedure

The study was conducted over a period of six weeks, following a structured approach to evaluate the impact of the intervention in a controlled lab setting. Initially, both the experimental and control groups completed a pre-test designed to measure their baseline responsive listening skills. The test included a variety of tasks, such as filling in blanks, arranging sequences, and answering short-response questions based on audio prompts. This assessment established a benchmark for comparing progress at the end of the intervention.

During the intervention phase, the sessions for the experimental group were conducted in a language lab equipped with computers for each student, all of which were connected to a central teacher's computer. The teacher controlled the audio clips and facilitated the sessions using the central system, ensuring synchronized delivery of the materials. This setup allowed for seamless management of the tailored audio content, ensuring consistency and clarity in the learning process. Research and technical assistants supported the intervention by monitoring the technical aspects of the lab and assisting with the session's flow. They also provided guidance during the pre-test and post-test phases to ensure accuracy and consistency in administering the assessments.

The experimental group engaged with the tailored audio materials during 30-minute sessions, held three times per week. These sessions focused on fostering active engagement with the audio content, encouraging learners to predict, infer, and respond critically. Meanwhile, the control group continued with their standard curriculum without additional audio-based input, ensuring a clear distinction between the two groups' learning experiences.

At the end of the six weeks, a post-test; essentially a modified version of the pre-test was administered to both groups. Conducted in the same lab setting, the post-test aimed to evaluate any changes in their responsive listening skills, providing a robust basis for analyzing the effectiveness of the intervention. The collaborative involvement of the teacher and technical assistants throughout the process ensured the smooth execution of the study.

3.5 Assessment Tool

Responsive listening skills were evaluated using carefully designed listening tasks that aimed to assess multiple dimensions of the skill. These tasks included comprehension exercises, logical sequencing activities, and prompts requiring learners to generate meaningful responses to audio input. Each task was tailored to reflect the interactive nature of responsive listening, simulating scenarios where students would need to engage critically and contextually with the content. Drawing from Vandergrift and Goh (2012), the tasks were structured to encourage active engagement with the audio material, mirroring real-world communication where listeners must process, interpret, and respond effectively.

The evaluation criteria were meticulously crafted to ensure a comprehensive assessment of students' abilities. Each response was scored based on accuracy, relevance, and contextual appropriateness, capturing the essence of responsive listening as a dynamic and interactive skill. Research by Field (2008) supports the importance of such multidimensional assessment approaches, emphasizing the need to evaluate not only comprehension but also the listener's ability to construct appropriate and timely responses within a given context. This dual focus on understanding and interaction made the assessment tools robust and aligned with the objectives of the study.

3.6 Data Analysis Method

The collected data were analyzed using statistical methods to evaluate the impact of the Technology-Based Intervention on the responsive listening skills of first-year engineering students. Tests were conducted using IBM SPSS Statistics v23 to ensure precise and reliable results.

A paired samples t-test was employed to examine the improvement in listening skills and its dimensions within each group (experimental and control) from the pre-test to the post-test stage. This analysis provided insights into how the intervention influenced the experimental group over time, while also tracking any natural progression in the control group.

Additionally, an independent samples t-test was applied to compare the experimental and control groups, both before and after the intervention. This analysis determined whether there were statistically significant differences in responsive listening skills between the two groups at each stage of the study. The application of this method allowed for a robust evaluation of the intervention's effectiveness, highlighting the distinct improvements observed in the experimental group.

The materials used for the intervention were carefully designed to align with the academic and professional contexts of engineering students. While the finalized audio files were produced using NaturalReader, an AI-based Text-to-Speech tool, the content itself was thoughtfully developed to provide engaging and contextually relevant input for the learners. This ensured that the intervention effectively addressed the specific needs of engineering education,

fostering an environment conducive to the development of responsive listening skills.

4 Results and Discussion

The study involved 70 first-year engineering students, divided into two groups: experimental and control. The experimental group received a Technology-Based Intervention designed to enhance responsive listening skills, while the control group followed their standard curriculum without additional input. The intervention utilized tailored audio materials relevant to engineering contexts, which were transformed into high-quality audio recordings using NaturalReader, an AI-powered Text-to-Speech tool. Responsive listening scores for both groups were recorded at the pre-and post-test stages to evaluate the effectiveness of the intervention.

For the experimental group, a paired samples t-test revealed a significant improvement in responsive listening scores from the pre-test to the post-test stages. This result highlights the impact of the carefully designed materials and their delivery through NaturalReader, which ensured consistent and engaging auditory experiences. In contrast, a paired samples t-test applied to the control group showed no significant improvement in scores between the pre- and post-test stages, demonstrating that the standard curriculum alone did not facilitate notable development in responsive listening skills.

An independent samples t-test comparing the post-test scores of the two groups indicated a statistically significant difference, with the experimental group outperforming the control group. This finding underscores the effectiveness of the Technology-Based Intervention, supported by the use of AI tools like NaturalReader, in fostering responsive listening skills among engineering students.

These results emphasize the value of integrating AI-driven tools with thoughtfully created educational content to address specific skill requirements. The significant improvements in the experimental group suggest that leveraging AI technology like NaturalReader in conjunction with domain-specific materials provides a robust framework for enhancing listening skills in specialized educational settings.

4.1 Comparison of Responsive Listening Skills in the experimental group

This section presents the comparison of Technology-Based Interventions for Responsive listening skill before and after intervention for first-year Engineering students in the experimental group.Paired samples t-test is applied to study the significant effect of Technology-Based Intervention on Responsive listening skills among first year Engineering students. The results are presented in Table 1.

Null Hypothesis $H_0$1: There is no significant improvement in Technology-Based Intervention for Responsive listening among first-year Engineering students

Table 4.1 Comparison of Technology-Based Intervention for Responsive Listening Skills in the experimental group

Variable	Intervention stages	Mean	S.D	t-value
Responsive listening	Before	14.43	0.54	41.325**

	After	20.41	0.89	(p = .000)

The obtained 't' value is 41.325 and it is significant at 1% level, $H_0$1(i) is rejected. The value indicates that there is a significant difference exists between before and after Technology-Based intervention with respect to Responsive Listening Skills.

Further, from Table4.1, the mean of Listening skills after the Technology-Based intervention is 20.41, which is significantly lesser than the mean of Responsive listening skills before the Technology-Based intervention (14.43). It shows that the Responsive listening skills of the first-year engineering students in the experimental group has significantly increased after the Technology-Based intervention; the intervention seems to be effective in terms of Responsive Listening Skills.

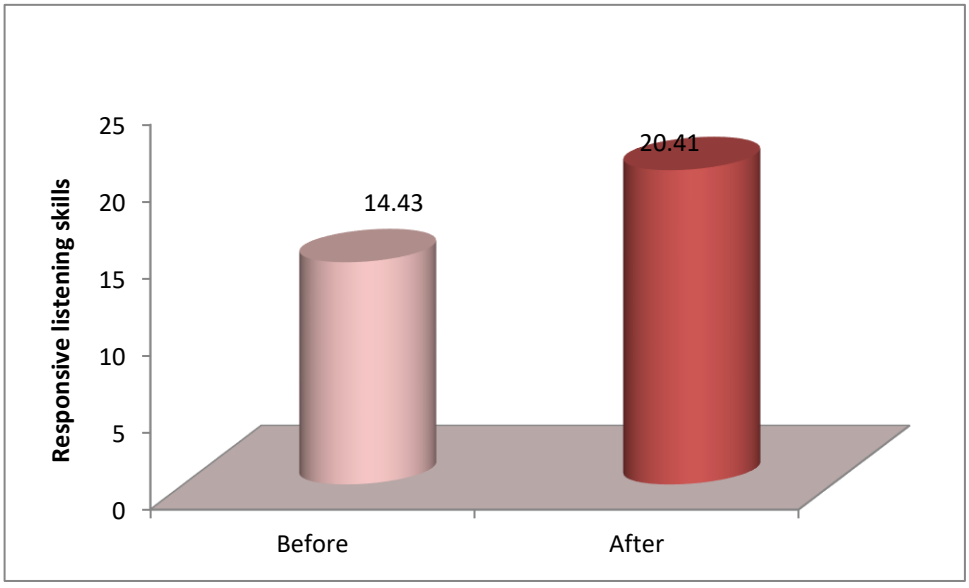

Figure 4.1: Comparison of Responsive listening Skills before and after Technology-Based Intervention in the experimental group

4.2 Comparison of Responsive Listening Skills in Control Group

This section presents the comparison of pre and post-scores for Responsive listening skills for first-year Engineering students in the Control group. Paired samples t-test is applied to study the improvement on Responsive Listening Skills of first year Engineering students from pre to post stages. The results are presented in the Table 2.

Null Hypothesis $H_0$2: There is no significant improvement from pre to post stages with respect to Responsive listening Skills among first year Engineering students in Control group.

Table 4.2 Comparison of Technology-Based Intervention for Responsive Listening Skills in the control group

Variable	Intervention stages	Mean	S.D	t-value
Responsive listening	Before	14.50	0.84	1.925

	After	15.15	0.94	(p = .076)

The obtained 't' value is 1.925 and it is not significant at a 5% level, $H_0$2 is accepted. This indicates that there is no significant difference exists between the pre and post-stages with respect to the Responsive listening Skills of first-year Engineering students in control group. This shows that, over the time period the Responsive listening Skills of first-year Engineering students in the control group has increased minimally but not significant.

4.3 Comparison of Experimental and Control Groups Before Giving Intervention for Responsive Listening Skills

This section presents the comparison of the Experimental and Control group before giving intervention on Responsive Listening Skills among first-year Engineering students. Independent samples t-test is applied to study the significant difference between Experimental and Control group before giving intervention for Listening Skills. The results are presented in Table 4.3

Null Hypothesis $H_0$3: There is no significant difference between Experimental and Control group before giving intervention for Responsive listening among first-year Engineering students.

Table 4.3 Comparison of Experimental and Control groups before giving intervention for Listening Skills dimensions

Variable	Intervention stages	Mean	S.D	t-value
Responsive listening	Experimental	14.50	0.54	0.829
	Control	16.40	0.84	(p = .409)

Responsive listening

It is observed from form Table 4.6, that the 't' value is 0.829and it is insignificant at 5% level, $H_0$3 is accepted. This indicates that there is no significant difference exists between the Experimental and Control groups with respect to the Responsive listening skills of first-year Engineering students before giving intervention. Responsive listening skills of first-year Engineering students seem to be the same in both Experimental and Control groups before giving intervention.

4.4 Comparison of Experimental and Control groups after giving intervention for Responsive Listening Skill

This section presents the comparison of the Experimental and Control groups after giving intervention on Responsive Listening Skill among first-year Engineering students. Independent samples t-test is applied to study the significant difference between Experimental and Control group after giving intervention for Responsive Listening Skills. The results are presented in Table 4.

Null Hypothesis $H_0$4: There is no significant difference between Experimental and Control groups after giving intervention for Responsive listening among first-year Engineering students

Table 4.4 Comparison of Experimental and Control groups after giving intervention for Listening Skills dimensions

Variable	Intervention stages	Mean	S.D	t-value
Responsive listening	Experimental	20.40	0.89	31.240**
	Control	15.55	0.94	(p = .000)

From Table 4.4, the 't' value 31.240 is significant at 1% level, $H_0$4 is rejected. The value indicates that there is a significant difference observed between the Experimental and Control groups with respect to Responsive listening skills after giving Technology-Based intervention to the first year Engineering students.

Further, from table 4.4, the Responsive listening skills of engineering students in the Experimental group is 20.40, which is significantly higher than the Responsive listening skills of engineering students in the Control group (15.55) after giving the Technology-Based intervention. The Responsive listeningSkills of the first-year engineering students in the experimental group is significantly increased after the Technology-Based intervention as compared with the Control group.

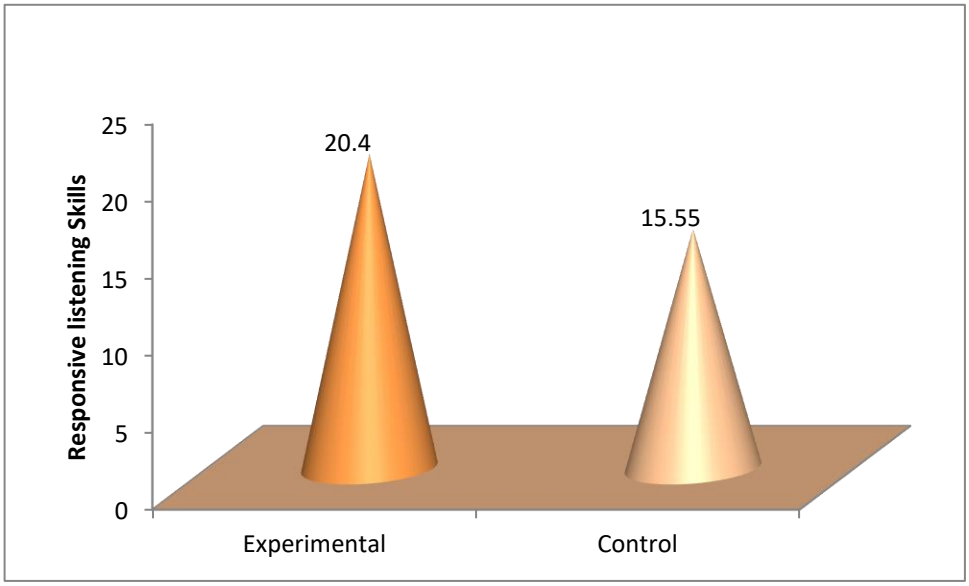

Figure 4.4: Comparison of Experimental and Control groups after giving intervention for Responsive Listening Skills

Findings

- The responsive listening skills of the experimental group showed significant improvement following the Technology-Based Intervention, confirming its effectiveness in enhancing these skills.
- Minimal improvement was observed in the responsive listening skills of the control group during the same period, with no statistically significant changes, underscoring the limitations of the standard curriculum in fostering responsive listening.

- Before the intervention, no significant differences were identified in the responsive listening skills of the experimental and control groups, establishing comparable baseline proficiency levels between the two groups.
- Post-intervention, the experimental group significantly outperformed the control group, highlighting the substantial impact of the Technology-Based Intervention on the development of responsive listening skills.
- The findings support the effectiveness of interventions guided by Krashen's Input Hypothesis

5 Scope and Future Research

This study demonstrates the effectiveness of integrating technology-based tools and domain-specific content to enhance responsive listening skills. This approach, rooted in Krashen's i+1 principle, holds potential for broader application across disciplines.While focused on first-year engineering students, the framework is adaptable to disciplines like healthcare, business, and law, where responsive listening is critical. The use of NaturalReader ensured scalable and accessible delivery, making such interventions viable across diverse educational contexts.

Future research could investigate the long-term impact of these interventions on professional performance, explore their adaptability in culturally and linguistically diverse settings, and expand the framework to integrate complementary skills such as speaking, critical thinking, and collaboration. By building on this approach, future studies can refine and extend the application of technology-based tools in responsive listening skill development, further addressing the needs of learners in specialized domains.

6 Conclusion

This study highlights the effectiveness of a Technology-Based Intervention in enhancing the responsive listening skills of first-year engineering students. By employing Krashen's Input Hypothesis as a foundational framework, the intervention provided comprehensible input that challenged learners at levels slightly beyond their current proficiency (i+1). This targeted approach facilitated meaningful engagement with domain-specific content, equipping students with skills critical for academic and professional success in engineering.

The results demonstrated a significant improvement in responsive listening skills within the experimental group, validating the intervention's effectiveness. In contrast, the minimal progress observed in the control group underscored the limitations of conventional instructional methods in addressing specialized listening needs. The use of AI-powered tools like NaturalReader further ensured the consistency and scalability of the intervention, making it a viable model for broader educational applications.

This research bridges theoretical constructs with practical applications, offering a replicable framework for integrating technology into skill development. Future directions include exploring the adaptability of such interventions across different disciplines and cultural contexts, as well as examining their long-term impact on learner outcomes. By emphasizing

innovative and contextually relevant approaches, this study provides a pathway for educators and researchers to address the evolving demands of modern education.

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