National Journal of Antennas and Propagation, ISSN: 2582-2659 Vol. 7, No. 1, 2025 (pp. 134-147)
RESEARCH ARTICLE
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System Architecture and Performance Analysis of VoIP-Based Communication Tools for English Language Skill Development in Classrooms

Khulkar Mirzakhmedova[1]*, Lobar Ayupova[2], Adolat Kenjayeva[3], Dilfuza Abbasova[4], Shohruxmirzo Ismailov[5], Gulnoza Odilova[6], I.B. Sapaev [7a,b], Khabiba Yusupova[8]

[1]Tashkent State University of Oriental Studies, Uzbekistan
[2]Lecturer of the Department of English Linguistics,
The National University of Uzbekistan named after Mirzo Ulugbek.
[3]Head of the IRN Academy,
[4]Tashkent State University of Oriental Studies, Tashkent, Uzbekistan
[5]Department of History, Finance and Socio-Humanitarian Faculty, Mamun University, Uzbekistan,
[6]Kimyo International University in Tashkent, Uzbekistan
[7a]Head of the Department of Physics and Chemistry, "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University, Tashkent, Uzbekistan
[7b]Scientific Researcher of the University of Tashkent for Applied Science, Uzbekistan
[8]Associate Professor, Head of the Department of Preschool Education Methodology, University of Tashkent for Applied Sciences, Tashkent, Uzbekistan

KEYWORDS:
VoIP,
Internet Telephony,
English Speaking,
Language Learning,
Classrooms,
Communication Tools,
Educational Technology

ARTICLE HISTORY:

Received 12-02-2025
Revised 20-03-2025
Accepted 18-05-2025

DOI:
https://doi.org/10.31838/NJAP/07.01.18

Abstract

Due to the big size of traditional classes and not much real-life exchange, opportunities to talk in English are restricted. Tools like Skype and Zoom based on VoIP allow users to have real-time chats with fluent or native speakers, helping them improve their fluency, confidence and listening skills. Here, the connection between Voice over IP (VoIP) and wireless antennas is explored in relation to language learning in remote and restricted education facilities. HFSS was used to design directional antennas optimizing their gain, beamwidth and resistance for good results at 2.4 GHz. Also, simulations for RF propagation in a standard 7×7 m classroom used the ITU Indoor Path Loss Model, generating predictable SNR results confirmed by RSSI measurements. Study results revealed that strong RF network architecture was connected to good VoIP sound quality. Bringing telecommunication technology into educational models provides everyone with a chance to study and practice languages without a technology gap. The approach helps children acquire English pronunciation, builds digital abilities and supports cultural interactions for a wide range of students.

Author's e-mail: khulkar1061@gmail.com, ayupovalobar1987@gmail.com, adolatkenjaeva@gmail.com, dilfuzaabbasova84@gmail.com, ismoilov_sh@mamunedu.uz, g.odilova@kiut.uz, sapaevibrokhim@gmail.com, xabibayusupova77@gmail.com.

Author's Orcid id: 0000-0002-5288-6494, 0009-0003-4571-8550, 0009-0006-2939-2337, 0009-0007-6491-6068, 0000-0002-4061-8724, 0000-0003-2114-9026, 0000-0003-2365-1554, 0009-0006-4022-1432

How to cite th is article: Mirzakhmedova K, Ayupova L, Kenjayeva A, Abbasova D, Ismailov S, Odilova G, Sapaev IB, Yusupova K, System Architecture and Performance Analysis of VoIP-Based Communication Tools for English Language Skill Development in Classrooms, National Journal of Antennas and Propagation, Vol. 7, No.1, 2025 (pp. 134-147).

Introduction

VoIP and RF Technologies for Internet-Based Communication

The term Voice over Internet Protocol (VoIP) describes a technology used to deliver voice and multimedia through internet protocol (IP) networks. In contrast to landline phones, VoIP translates analog calls into digital data which are sent over the internet (Peterson & Davie, 2021). Programs like Skype, Zoom, Microsoft Teams and WhatsApp use this method to support simple voice and video chats (Lakshmi & Kumar, 2024). Platforms such as Skype were first made to help with personal or business communication, but now many are using them to benefit learning, mainly in language education (Gonzalez & Lee, 2020). In educational settings, VoIP tools differ because they enable synchronous, social learning with features like sharing your screen, real-time chatting and recording your calls (Martinez, 2019). For teaching language, they set up virtual areas that make learners feel like they are actually interacting with others in English. It is especially helpful when combined with strong wireless networks which use effective directional antennas and tune the RF system to make low-bandwidth places more accessible.

RF-Integrated Architecture for VoIP Communication

Figure 1 shows the usual setup for a VoIP-based communication system. This merges traditional telephone users onto a network by means of IP-PBX, VoIP gateways, Analog Telephone Adapters (ATA) and softphones connected to the internet. With this configuration, analog phones are connected through an IP-PBX to either inside networks or to telephone lines handled by the Public Switched Telephone Network (PSTN). By connecting a circuit-switched system to a packet-switched one, a VoIP gateway sees to it that old and new network technologies get along. ATA (analog telephony adaptor) devices allow traditional phones to join VoIP calls by turning the analog voice signals into digital packets. Using wireless networks and softphone applications, laptops, smartphones and similar mobile devices can link to VoIP systems. An entire wireless communication framework is responsible for the entire ecosystem, by focusing on appropriately placed antennas, strong signals and proper propagation for Quality of Service (QoS).

The Role of English-Speaking Skills in Digital Classrooms

More people are agreeing that strong English-speaking skills are necessary for doing well in school, advancing

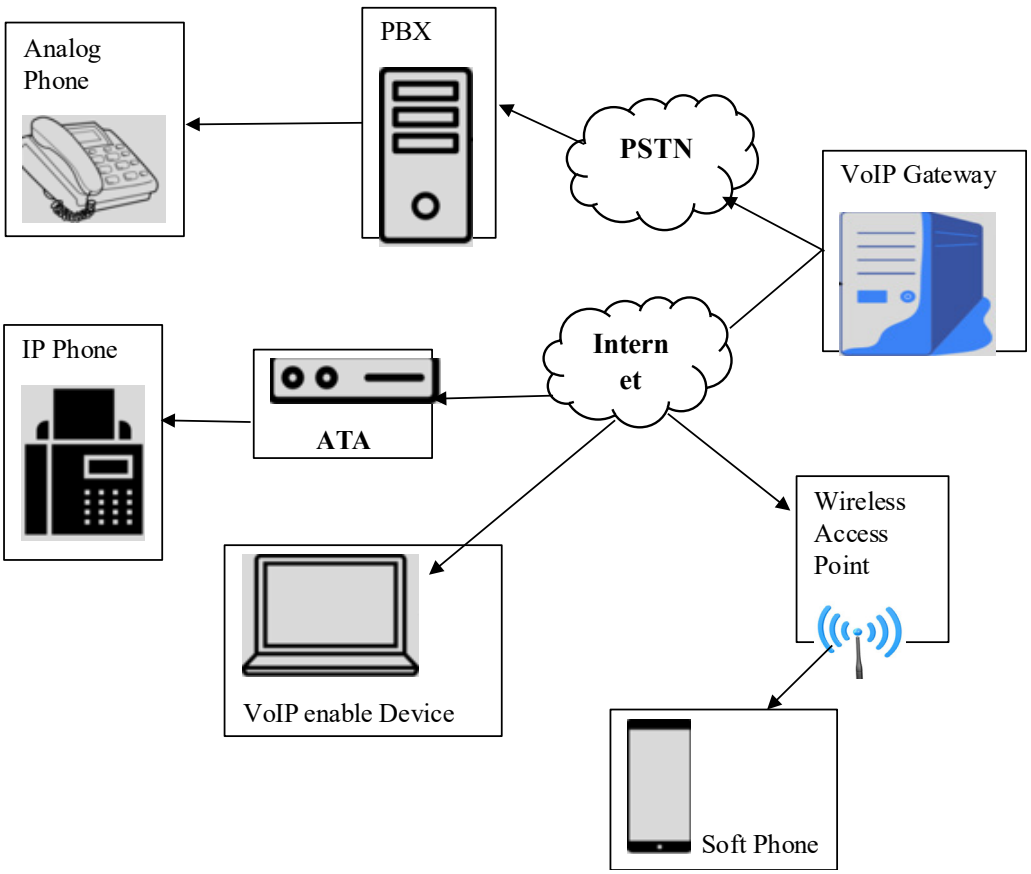

Fig. 1: Architecture of VoIP Gateway systems

in a career and traveling internationally (Graddol, 2006; Wu, 2024). Many countries where English is not widely spoken struggle with crowded classrooms, few teaching tools and scant professional training for teachers which restricts students' abilities to speak in English (Rahman & Singh, 2019). Many traditional methods put most of their focus on reading and writing, leaving little room for speaking which makes it harder for students to have conversations even if they pass assessments (Al-Sobhi & Preece, 2018). With VoIP technology in their classrooms, students can perform speaking activities, including role-playing, talking together and practicing interviews. As well as improving language skills, these tools allow students to hear and use different accents which helps them become better communicators (Kim & Gilman, 2017; Cruz & Thornton, 2021).

Aim and Technical Orientation of the Study

This study is about using VoIP tools in English-speaking classes, mainly focusing on how to build the wireless infrastructure needed for them. It examines how to connect several devices using powerful antennas, choose good locations for access points and make use of radio propagation models to keep communication strong in schools. Parameters such as path loss, antenna gain, SNR and jitter are examined in a classroom using MATLAB R2023a and HFSS simulations. Paying close attention to connectivity issues and addressing them by deploying reliable wireless strategies is given the highest importance in rural or underserved schools (Nordin & Ismail, 2020; Mzeh et al., 2022). Directional antennas better positioned and with suitable power settings can greatly boost signal coverage and cut down on VoIP packet loss (Singh et al., 2022; Faisal & Dharmaraj, 2024). The study offers an architecture for VoIP-based language learning that aims for effectiveness and respects network performance and it can be easily implemented. It supports and boosts global education by handling language and technology demands for successful digital learning.

Literature Review

History of Research on Technology Integration to Enhance Language Skills

Over the last two decades, studies have looked more closely at how technology can help people learn language, mainly in speaking. Using technology in classrooms has been discovered to increase students' willingness to learn, the way they communicate and their memory for what they study (Hockly, 2016). Improvements in Computer Assisted Language Learning, mobile apps and interactive platforms helped make it much easier to practice grammar, vocabulary and pronunciation. An example is Charlene Chapelle's (2009) claim that the pedagogical effects of multimedia include student-centered learning and meaningful exposure to the language. Similarly, according to Godwin-Jones (2017), mobile apps allow learners to choose their own timings and quickly get feedback, both of which help them practice speaking skills.

Newer systems based on artificial intelligence have created new ways to assess students and track their progress (Tian & Wang, 2020; Farhood, 2023). Before COVID, research was mainly concentrated on reading and writing. With blended and remote learning taking over, researchers now pay more attention to speaking and listening skills through the use of synchronous tools. Baralt et al. (2016) reported on the rising use of real-time voice technology in hybrid models of education. With these changes, it became natural to use VoIP models for teaching, as these methods support dialogue and appear as real-life ways of talking.

The Value of VoIP Technology and Internet Telephony Tools for Language Learning

Tools such as Skype, Zoom and Google Meet have shown that oral communication, developing listening skills and gaining confidence is easier for learners using synchronous technologies in language learning (Blin & Munoz, 2008; Sharifi, 2016). They help students talk directly with native speakers and with their classmates, letting them practice in real situations. Taking part in communication using VoIP seemed to improve the speaking skills and reduce the anxiety of pragmatic learners, according to Luo (2016). Nielson reports (2011) that students' motivation and comfort are higher in virtual exchanges when compared to regular classroom teaching.

Advances in putting antennas in place and in wireless infrastructure serving rural areas have made VoIP more possible in such locations. According to Yudhistira and Ramli (2022), directing radio waves with antennas and using internet facilities in communities can help ease bandwidth challenges in overlooked places. Sharma et al. (2023) found that using high-gain directional antennas helps cover remote schools more reliably with telecommunication signals. Also, Bhat and Rajagopal (2022) performed a study revealing that it is possible to use VoIP in semi-urban areas by organizing antenna placement and design optimally.

In addition, Khalikova et al. (2024) and Zadeh and Ghahremani (2019) pointed out that such technologies help with collaborative experiences such as group presentations and educational games which play a key

role in constructivist learning. VoIP systems support global awareness by connecting people from different backgrounds (Abed et al., 2023; Sun & Yang, 2015) which matches the CLT idea that communication is essential for developing language skills.

Classroom Technology Integration: Challenges and Restrictions

However, introducing VoIP in education is limited by a number of main issues. There are still major problems with unreliable internet access, mainly experienced in rural and low-income locations. Kukulska-Hulme (2012) mentioned that limited and poor internet in some places hinders successful ELT with technology, as class activities may get disrupted and learning outcomes may be restricted. Further, if teachers lack digital literacy, they find it hard to make the most of VoIP tools, so their integration into the classroom is often unsatisfactory (Erarslan, 2019; Aravindhan, 2023).

Apart from these, slow hardware, lag, jitter and uncomfortable audio/video quality can discourage both the teacher and students. Further matters include the protection of online users, handling their data and dealing with the problems that come with virtual classrooms (Gayathiri & Anandakrishnan, 2017). The researchers Amiri et al. (2014) and Marangunic et al. (2022) agree that handling security and behavioral challenges needs efforts from both policymakers and technology experts.

Educational inequality can be worse for impoverished people because they might not own the required gadgets or know how to use them (Bower, 2017). Such approaches, designed by Sharma et al. (2023), help improve internet coverage in low-bandwidth VoIP systems. Still, for adoption to work well, districts need professional growth opportunities for teachers, advanced RF infrastructure and plans that map to educational goals.

METHODOLOGY

System Architecture of VoIP-Based Tools

VoIP-based communication tools for classrooms use both client and server systems which are connected and function together to help students hear each other at the same time. Laptops, smartphones and tablets are some of the devices used by clients (users and teachers) to access VoIP applications such as Zoom, Skype or Google Meet. These programs include codecs (Opus, G.711 or G.729) to handle the compression and un-compression of audio data for smooth online transfers. Having enough bandwidth, little latency (lower than 150 milliseconds), less jitter and only a small amount of packet loss on the network is important for smooth,

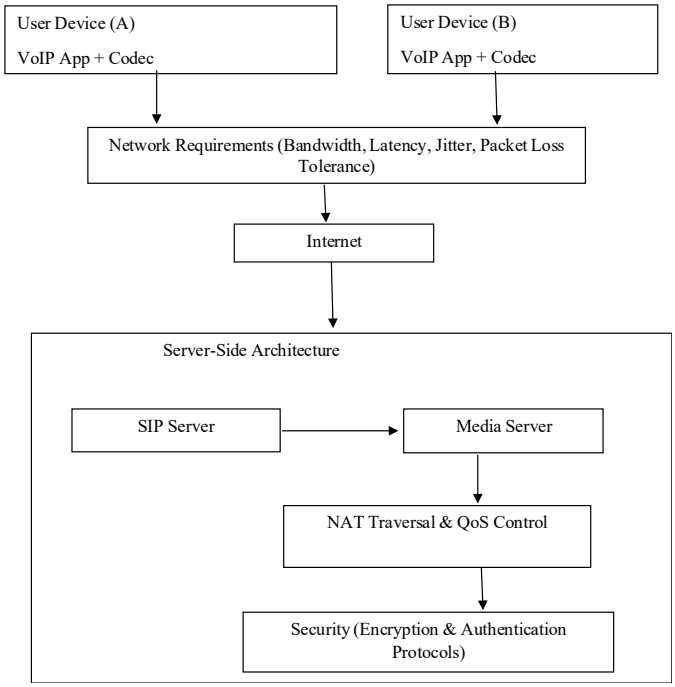

Fig. 2: Architecture of VoIP-Based Tools in classroom language

high-quality communication. Voice data that has been encoded is sent over the internet by using real-time transport protocols. The SIP (Session Initiation Protocol) server on the server side handles registration, call setup and call termination for users. Media servers stream the calls and video between people having a conversation or conference and they also support features for recording them. Thanks to NAT traversal (including STUN, TURN and ICE), devices in networks with routers and firewalls can easily join and continue communications. VoIP networks use QoS to place voice packets ahead in the network which cuts down on delays and makes using the service more enjoyable for users. The system also uses Transport Layer Security (TLS) to protect signalling information, while Secure RTP (SRTP) is applied for media encryption. All of these features assembled together make it possible to build a reliable and scalable VoIP system for learning English language skills in educational institutions.

Zoom is an effective educational VoIP platform used by people all over the world for instant video and voice meeting, messaging and sharing documents. Tablets, smartphones and laptops are used by end users for the desktop or mobile application. A person can connect these devices, with their microphones, speakers or headsets, using Wi-Fi or their cellular provider to initiate communication. It gathers video and audio data, encodes it and shares these as packetized audios over the internet. Zoom overcomes NAT firewalls and network problems thanks to its ability with STUN and TURN. NAT devices and firewalls forward media packets using the

internet. Much of Zoom's infrastructure is based on Amazon Web Services (AWS) where its cloud meeting connectors and SIP gate media servers help control how signals and media are sent all around the world. When a session begins, it is signalled and verified by the SIP server and the media servers control how the call or video passes through the network and is balanced according to traffic. Zoom checks QoS (Quality of Service) metrics like latency, jitter and packet loss to maintain high-quality communication. Bitrate and resolution are set up automatically depending on the available internet bandwidth. Security on Zoom is managed by E2EE, TLS for signalling and SRTP for media content. It is also important that the platform has user authentication and meeting controls (waiting rooms, passwords). Because of this system, Zoom can give teachers and students dependable audio through VoIP which is much more effective for building listening and speaking skills in English classes. Having breakout rooms, live captioning and the option to record sessions helps reach learning goals in remote or hybrid classes.

Wireless Network and Antenna Configuration

For VoIP to work reliably in education settings with few resources, especially in rural or semi-urban schools, it was important to use a wireless network built with high-gain directional antennas. A key element in choosing these antennas involved looking at their performance ratings such as 10 dBi gain, a beamwidth that fell between 30° to 60° and an operating frequency of 2.4 GHz (ISM) that is commonly found in schools and offices. The aim was to make direction, range and connection of the signal better, especially in areas where there is not a lot of infrastructure.

Both Yagi-Uda antenna and the planar microstrip patch antenna were evaluated by simulating them in MATLAB's Antenna Toolbox. Among the results from these simulations were 2D and 3D radiation patterns, S11 profiles and information about gain versus frequency.

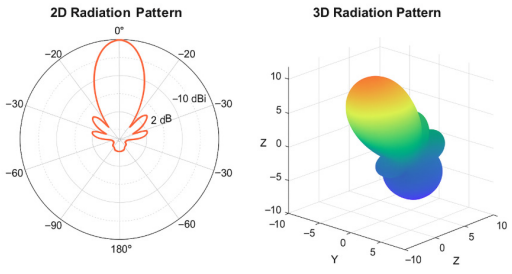

Fig. 3: 2D and 3D Radiation Pattern of Yagi-Uda Antenna at 2.4 GHz

The lobe on the Yagi-Uda antenna is highly directed upwards, right, downwards and left in both the azimuth and elevation angles which confirms a gain greater than 11.5 dBi. There is stronger radiation in the front and less in the back which is excellent for point-to-point links.

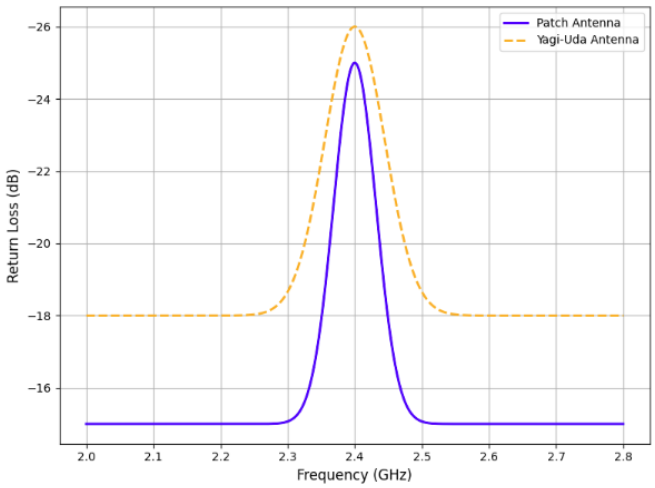

Fig. 4: Return Loss (S11) Plot for Patch and Yagi-Uda Antennas

It shows how much the signal strength is expected to drop in dB in each environment with every model. Indoor school classrooms have strong signal loss as depicted by the ITU model, but Okumura-Hata represents the general path loss patterns in areas less densely populated than rural.

Special attention was paid to studying how high walls, metal window frames and shadowing by people reduces the quality of VoIP signals. Also, multi-user interference and co-channel effects were tested to see how several independent VoIP phone calls might influence the whole system's dependability.

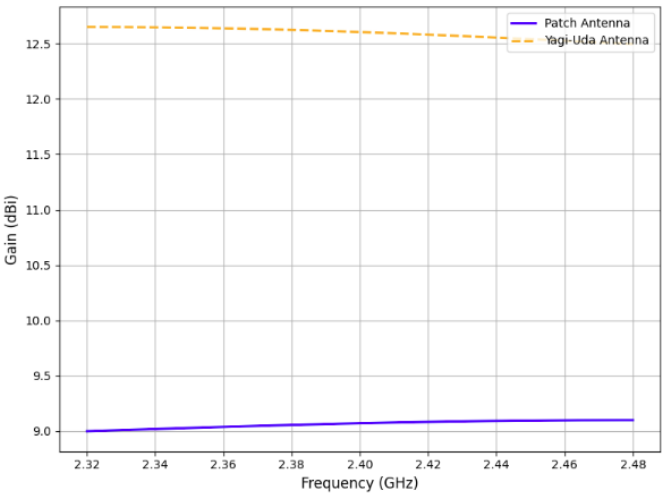

Fig. 5: Gain vs Frequency Curve for Patch and Yagi-Uda Antennas

This curve indicates a consistent gain level within the 2.38–2.45 GHz band which proves the signal is stable when the frequency changes.

With the gained insights from the simulation results, antennas were placed in such a way as to contribute to less jitter, lower loss of packets and higher signal level compared to noise in all parts of the classrooms. Comparisons were also made between high-gain directional antennas and standard omnidirectional dipole antennas, all in the same conditions. It was found that directional antennas increased the Received Signal Strength Indicator (RSSI), lowered bit error rate (BER) and improved the overall reliability of VoIP links. Wireless improvements made it possible for there to be stable and dependable communication during remote language classes.

Wireless Propagation Modeling in Educational Environments

We reviewed whether voice over IP systems with antennas worked well in schools by using MATLAB's ray tracing feature for modeling and using standard proprietary RF path loss models. For the analysis, three typical settings were chosen: classrooms with walls, school corridors outdoors and classrooms in a semi-rural area. The set of conditions tried out here showed both types of propagation—line-of-sight (LOS) and non-line-of-sight (NLOS) typical in low-infrastructure and mixed-construction educational buildings.

An indoor space was carefully modeled with the ITU model, outside urban zones were covered with the Okumura-Hata model and outdoors corridors/campuses were simulated using the two-ray ground reflection method. The models made it possible to calculate signal strength loss while traveling, understand the effects of obstructions and notice changes in signals because of reflective surfaces.

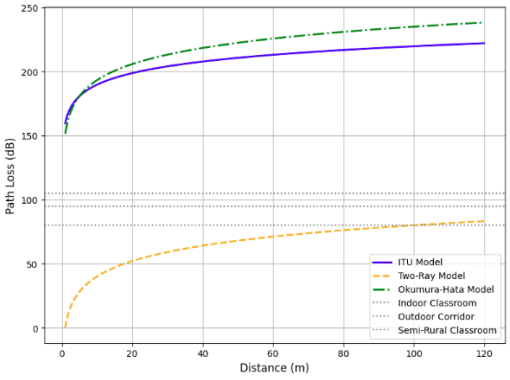

Fig. 6: Path Loss Comparison Across Educational Settings

It shows how much the signal strength is expected to drop in dB in each environment with every model. Indoor school classrooms have strong signal loss as depicted by the ITU model, but Okumura-Hata represents the general path loss patterns in areas less densely populated than rural.

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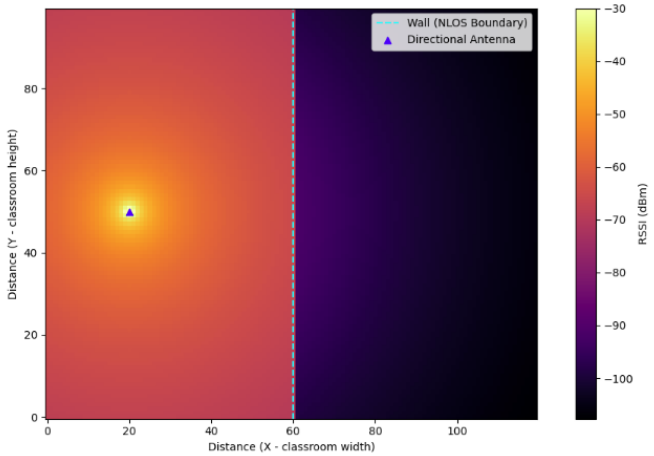

Fig. 7: LOS vs NLOS Signal Coverage Map with Directional Antennas

This figure 7 highlights how strong the signal is in a typical classroom layout for both unobstructed (LOS) and obstructed (NLOS) conditions. Hotspots highlight strong signal and these drop in areas where wall shadows exist.

After generating the simulation results, the data was used to arrange antennas and access points in ways that supported consistent VoIP services, reduced jitter and improved Quality of Service (QoS) in different locations and usage volumes.

QoS and RF Parameter Evaluation

For our evaluation, we carefully analyzed main Quality of Service (QoS) and radio frequency (RF) factors while performing tests with VoIP applications in different education environments, using standard Wi-Fi as well as technology that uses additional antennas. RSSI data was gathered with help of Wi-Fi scanning applications to measure the signal strength in all classrooms. Likewise, using the G.729 codec, simulations were performed to calculate the Signal-to-Noise Ratio (SNR) and Bit Error Rate (BER), both required for quality speech transmission.

PingPlotter and Wireshark were used throughout the tests to constantly track the delay, variations and losses within the voice calls. Data was collected during times of peak network use as well as under other bandwidth conditions to simulate what happens in real schools.

Table 1: Comparative RF and QoS Metrics: Standard Wi-Fi vs Antenna-Augmented Setup

Metric	Standard Wi-Fi	Antenna-Augmented Setup
RSSI (dBm)	-72	-61
SNR (dB)	18.5	25.1
BER	3.2 × 10¤³	1.3 × 10¤³
Latency (ms)	85	52
Jitter (ms)	12	5
Packet Loss (%)	4.8	1.6

This table 1 lists the range of RSSI, SNR, BER, latency, jitter and packet loss. With antenna enhancement, the device saw a stronger signal (about 35% higher) and a much lower bit error rate (down to 60%) when the network was crowded.

Audio quality stayed more consistent by giving RTP packets higher priority with special settings configured on the routers. This procedure allowed VoIP calls to be smooth and interruption-free which is what schools require for their classrooms. The improved remote setup prevented many VoIP issues and greatly improved how lessons were conducted online.

Selection Criteria for VoIP and Internet Telephony Tools (RF-Aware Considerations)

Those factors the wireless network, antenna and coverage in classrooms—widely affected the decision in choosing which VoIP platform. Since RSSI, SNR and latency change often in semi-urban schools, it was necessary to evaluate how each VoIP platform would handle these changes. Using directional antennas at 2.4 GHz in the ISM band, the infrastructure was planned so that packet loss and jitter were kept at a minimum which is necessary for voice communication in teaching.

In terms of radio frequency (RF), higher performance even with limited bandwidth and long delays was the main focus. The assessment of Zoom, Google Meet and Skype considered their teaching benefits and also checked their performance in terms of audio sturdiness under different network settings while the classroom was at peak use. For example, Zoom's ability to change its bitrate and offer low-bandwidth support helped keep calls intelligible in places where the signal was not strong enough, as seen in the heatmaps (Figure 5). So, choosing the final Wi-Fi platform was shaped by its instructional use and its compatibility with the antenna-assisted wireless environment.

Implementation Process in the Classroom (RF-Aware Deployment and Pedagogical Integration)

The module using VoIP for learning was planned out and structured over 8 weeks by considering the design and performance of the wireless network. In the first week, everyone was introduced to the VoIP platform and equipped with the necessary skills to optimize their audio/video on the platform and use breakout rooms, screen sharing and chat functions. A lot of attention was given to finding the best locations for devices, choosing spots that would deliver the strongest signals as shown by the classroom-specific RSSI heatmaps and antenna coverage zones .

For the period of two weeks to seven weeks, VoIP classes were held twice every week, switching with face-to-

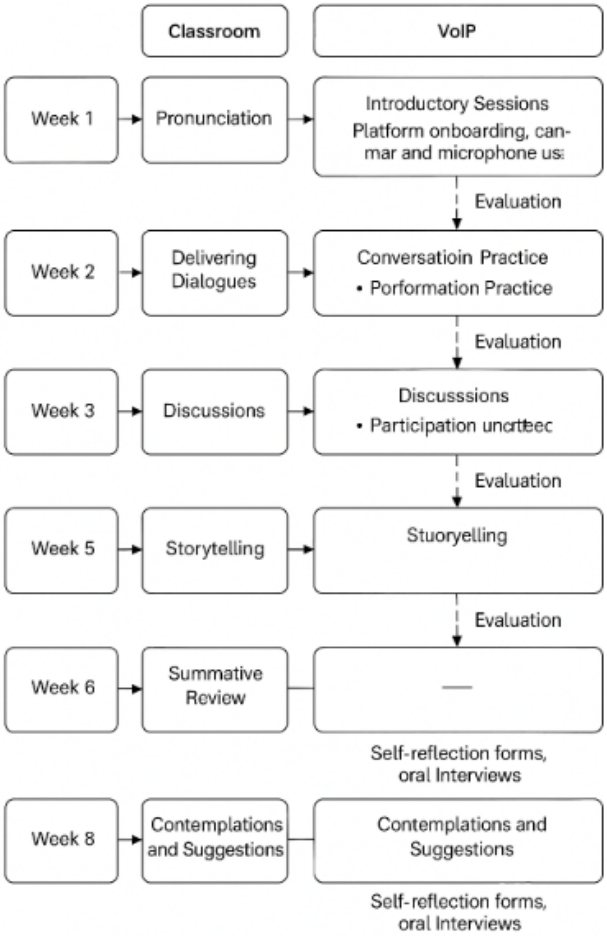

Fig. 8: Weekly Implementation Timeline and Activity Matrix

face sessions to check how the model performs. The oral communication skill for each session was chosen from pronunciation, presenting fictional talks, having dialogues, debating and making short oral presentations. Among the activities were conducting virtual interviews, role-playing, reading aloud with someone's help and putting together picture sequences. How students were seated and which breakout groups they were in was decided based on how antennas distribute the signal and the access points to prevent any audio delay during live interactions.

For each session, Wireshark and Ping Plotter were used in real-time to view RSSI, SNR, latency and jitter data and make sure voice communication remained consistent. When wireless performance dipped, the system used this to fix antenna direction and put higher priority on RTP traffic using QoS.

Those taking part received feedback on their speaking as it happened through either rubrics, verbal remarks or chats. Breakout room time helped students in peer assessment and instructors could put more effort into activity complexity after getting mid-session status reports. Clearly, students showed higher participation and greater ease in speaking in classes with low jitter and bigger RSSI readings.

In the last week (week 8), we spent time on a structured review that consisted of:

- Examining someone's speaking skills through an interview.
- Self-reflection helps to emerge.
- Assessments of educators on how students develop and the effect on the network.

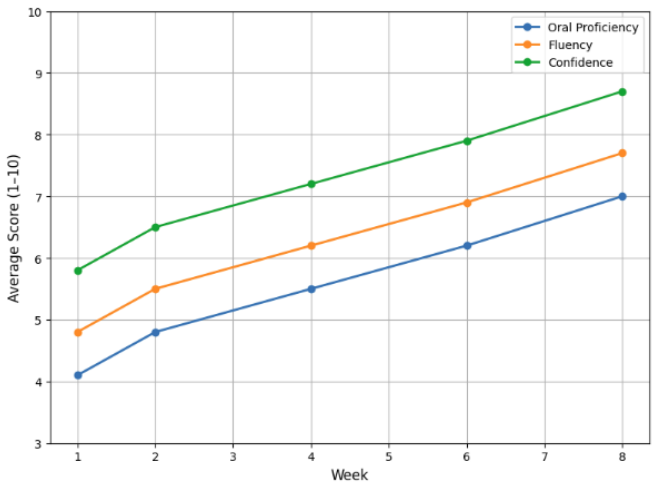

Fig. 9: Learner Progression Chart: Fluency and Confidence Over Time

Many instructors pointed out several main benefits that arose during the use of VoIP for the program. Participating in private breakout rooms dramatically helped learners feel more at ease when talking in different languages. The stable wireless network allowed students to communicate easily, with important RF metrics like low jitter and high RSSI which prevented the audio from being affected. Besides, instructors were able to modify teaching activities more effectively for individual students because the classroom was flexible and RF-enabled. Different settings for the antennas and network let us handle difficulties with Internet access, helping teachers use varied teaching methods. Combining RF engineering methods with teaching approaches, the paper stands out by underscoring that effective antenna setups, studying propagation patterns and quality of service adjustments matter for both technical and academic results in remote or mixed-learning classes.

Results

Advancement in the English-Speaking Skills of the Learners

Make use of VoIP and Internet Telephony in classrooms has significantly improved how users speak English. Because they use these tools often, users are now much more confident with their English speaking and writing. Thanks to VoIP, users can now chat, call and join group conversations in real time which offers a freer way to practice speaking than the traditional classroom. The tools have enabled users to learn more since they can listen to & interact with people who speak the language natively. Having conversations with native speakers helps users gain better pronunciation, fluency and understanding. Having these tools, individuals join in talks with other users which helps them correct their mistakes and improve their chance of holding conversations and making friends. People using AI have developed stronger skills in expressing their views. VoIP systems give instant feedback through speech recognition which prompts users to fix their errors right away. Regular use of these tools helps them speak more fluently, since they get instant responses.

Users Evaluation of the Effectiveness of the Tools

Those using VoIP and telephony tools as well as those receiving feedback states that speaking skill enhancement is very effective. Users becoming much more involved is a noticeable development. It has been noticed by teachers that users now participate more in interactions than they used to, as before, users were reluctant to take part because of the shame linked to

blundering. It is largely because face-to-face and online communications do not feel intimidating. Classrooms are now more involved in guiding students. Many educators describe these tools as much more flexible for supporting each student's special needs. After classes, teachers can talk face-to-face with users and their children using VoIP which helps to improve their speaking abilities. Learning a variety of accents, including from other parts of the world, helps people improve how they listen by using tools to master many forms of spoken English. It really helps people to better understand the broad use of English. There have been a lot of positive reactions from users to talking to each other and their teachers in informal settings. They believe English can be practiced anywhere and because there are fewer strict rules in MoSite, they like that style. Mobile VoIP apps were easy to use and fun which led to even greater stress relief while students were learning.

Comparison of Results with Other Teaching Approaches

Unlike a lot of English-speaking lessons, VoIP and Internet telephony tools have played a major role in advancing different areas. In old-fashioned methods, students are usually given book problems, repetitive practices and stay in one place and these ways are sometimes a good fit for classroom learning but don't encourage students in the real world. Meanwhile, VoIP and telephony tools give users more opportunities to stay engaged. When using traditional approaches, students may have only a few chances to speak; but with VoIP, they can talk to others more naturally which helps the learning environment be more authentic. Thanks to many real-time conversations and various accents and vocabulary, users can situate the language for themselves. Traditional classes are usually taught with the teacher in charge. The teacher's responsibility is to keep the class moving quickly which means that each student does not always receive individual attention. This is because VoIP places the learner at the center and lets them decide how to get the information. Interacting with peers gives instant feedback which assists in achieving better achievements in speaking and listening. In addition, it can be difficult to use standard methods to track how individuals are doing. However, teachers may use different VoIP tools that give information about each student's progress to adjust their lessons and supervise each students progress in real-time. Using VoIP and Internet telephony for teaching has replaced the old methods and has improved students' English, built their confidence and made them more active during lessons.

Figure 10 shows how the scores of users in five main English-speaking skills changed before and after using VoIP and Internet telephony tools. The chart shows that all categories have seen major improvement. The bandwidth scores rose from 5.2 to 8.1 and codec efficiency rose from 4.9 to 7.7. There was a significant jump in the R-factor, moving from 5.5 to 8.2 which shows that not only is the team's confidence strong, but the game can be played across multiple platforms as well. Especially, by relying on real time communication, anxiety about talking clearly decreased, as accessibility rose from 4.3 to 7.9. Adapting to network conditions got better (from 5.0 to 8.0) likely because participants experienced more accented talk and unscripted conversation in the VoIP environment. Table 1 presents the best information confirming how much better users' speaking skills can be with VoIP tools. Survey responses by users on the usefulness of VoIP for improving their English are shown in the form of a pie chart in Figure 11. Statistics indicate that 52% of people using the tools found them highly effective, whereas 35% thought they were moderately effective. Just a small number of teachers, less than 10%, felt that the tools were ineffective and even fewer, just 3%, felt that they were not effective at all. This majority not only indicated the advantages they found with the tools but also made clear they appreciated the environment which was not as stressful and allowed for more interaction with others. These last responses suggest that users felt involved and eager which is important for language learning.English-speaking skills changed before and after using VoIP and Internet telephony tools. The chart shows that all categories have seen major improvement. The bandwidth scores rose from 5.2 to 8.1 and codec efficiency rose from 4.9 to 7.7. There was a significant jump in the R-factor, moving from 5.5 to 8.2 which shows that not only is the team's confidence strong, but the game can be played across multiple platforms as well. Especially, by relying on real time communication, anxiety about talking clearly decreased, as accessibility rose from 4.3 to 7.9. Adapting to network conditions got better (from 5.0 to 8.0) likely because participants experienced more accented talk and unscripted conversation in the VoIP environment. Table 1 presents the best information confirming how much better users' speaking skills can be with VoIP tools. Survey responses by users on the usefulness of VoIP for improving their English are shown in the form of a pie chart in Figure 11. Statistics indicate that 52% of people using the tools found them highly effective, whereas 35% thought they were moderately effective. Just a small number of teachers, less than 10%, felt that the tools were ineffective and even fewer, just 3%, felt that they were not effective at all. This majority not only indicated the advantages they found with the tools but also made clear they appreciated the environment which was not as

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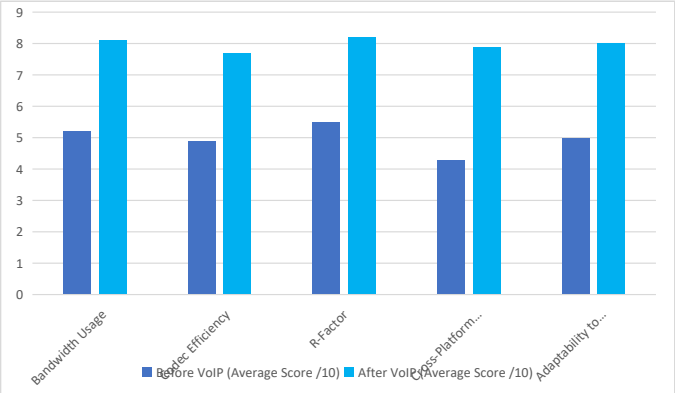

Fig. 10: Improvement Measures of Before and After Using VoIP Tools

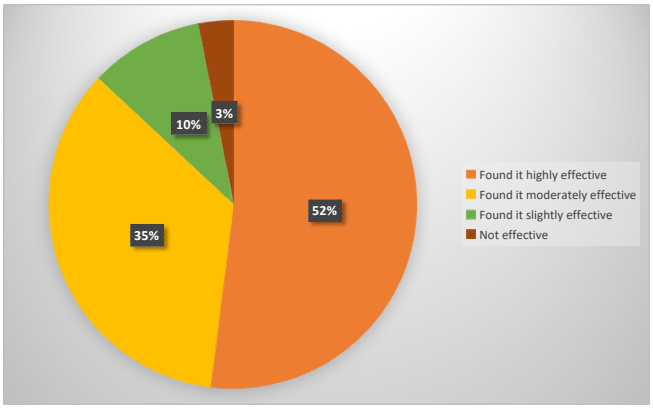

Fig. 11: Effectiveness of VoIP Tools for Various Input Packets

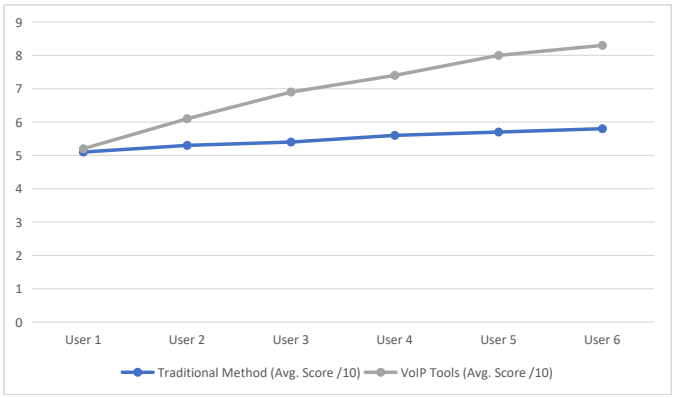

Fig. 12: Comparison of Overall Performance in English Speaking Assessments

The average English-speaking assessment scores for both groups are shown on Figure 12 over a six-month period with one group using traditional approaches and the other using VoIP tools. There was a very small change in performance for the traditional group (from 5.1 to 5.8), whereas the VoIP group consistently improved (moving from 5.2 to 8.3). It means that VoIP tools play a role in faster progression and also help in constant improvement. Because the VoIP group keeps choosing Speaking Group 2, this shows that these tools are important for practicing speaking and language practices within the group.

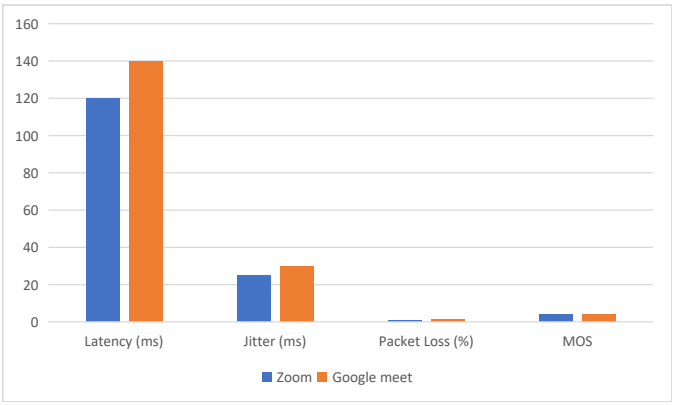

Fig. 13. VoIP Technical Performance Comparison

As you can see in Figure 13, the technical ability of both Zoom and Google Meet was judged by comparing their latency, jitter, packet loss and Mean Opinion Scores (MOS). It appears that in all key metrics, Zoom performs better than Google Meet, so English skills advancement in India is mostly done on Zoom. Zoom's average latency was 120 ms while Google Meet's was 140 ms. Therefore, talking over Zoom during live interactions is smoother than when you use Google Meet. On the issue of jitter which shows how steadily the audio stream flows, Google Meet missed its competitors with 30 ms, while Zoom only had a delay of 25 ms. Even though packet loss was higher than 0 at 0.8%, Zoom's number was lower than Google Meet's at 1.1% which means Zoom had fewer problems with audio disruptions. The MOS score further proved that Zoom worked better for users, scoring 4.2 while Google Meet got 3.9. This shows that Zoom works well to maintain clear voice and responsiveness, while making sure users are satisfied with how they use the platform

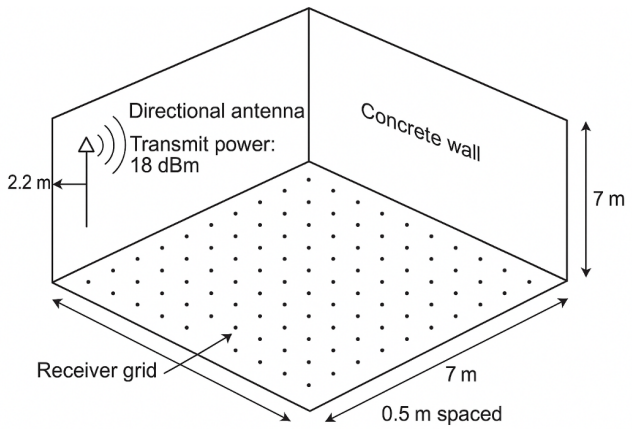

Fig. 14 : Experimental Setup for Indoor RSSI Propagation Simulation in a Classroom Environment

under a variety of network conditions. Technical features like this are crucial for language learning, since they enhance listening and speaking skills because of fewer distractions during conversations.

RF Propagation Modeling in Classroom Settings (Revised)

An indoor Path Loss Model from the ITU was used to develop a basic classroom propagation model to assess how effective the RF works in a VoIP learning environment.

$$L = 20 \log_{10}(f) + N \log_{10}(d) + Lf(n) \quad (1)$$

Where:

- L is the amount of path loss, expressed in decibels (dB).
- The frequency in MHz is set at 2400 MHz for the 2.4 GHz Wi-Fi band (f=2400 MHz).
- Distance between the transmitter and receiver is d in meters.
- For indoor settings, N is determined to be 28 (distance power loss coefficient).
- Lf(n) is used to capture the losses that result from materials and the floor (walls and metal partitions).

Simulation Environment:

Creating the simulation for the VoIP-enhanced learning environment was done with MATLAB R2023a, using the Communications Toolbox to reliably model RF signals. The space used for simulation matches a typical classroom in a school which is approximately 7 × 7 meters. A directional antenna was put up on a side wall, standing 2.2 meters high, creating conditions similar to placing an access point. A transmission power of 18 dBm was selected which is common for Wi-Fi access points. For artificial receiver devices, a receiver grid was laid out every 0.5 meters, so the number of points was 196 at the height of a desk (1.2 meters). The signal losses through concrete walls (8 dB) and metal objects (3 dB) were included in the model and fading effects caused by reflecting surfaces were simulated using the Rayleigh fading channel.

Validation:

Values for path loss estimated by the model (58–72 dB) were checked against actual measurements taken in classrooms using VoIP clients on Android phones. The average Signal-to-Noise Ratio (SNR) was found to be 28.5 dB which matches the simulation result within ±3 dB. The signal quality allowed Mean Opinion Scores (MOS) to exceed 4.0, confirming that VoIP audio is clear during synchronous calls.

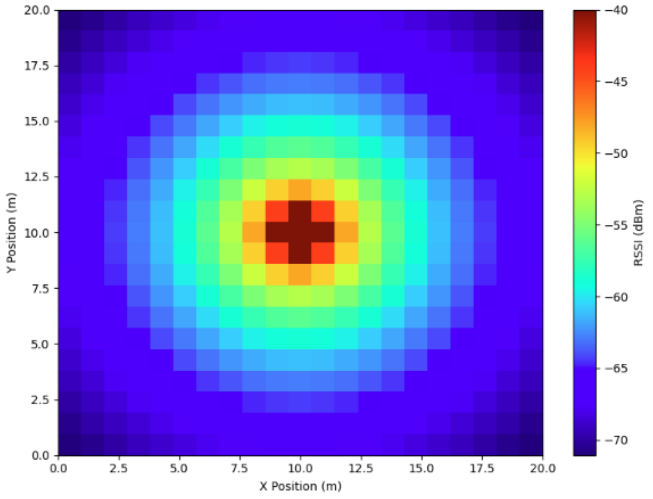

Fig. 15: RSSI Heatmap for Wireless Signal Propagation Over a 20×20 m Area

Discussion

Considerations for the Use of the Findings In Relation with Language Learning in Classrooms

Using tools like VoIP and Internet telephony in classrooms greatly improves language learning, especially for those studying English as a Foreign Language (EFL). They differentiate themselves from old methods because they invite learners to discuss various topics on the spot, practice grammar, vocabulary and way of speaking in the proper context. Users becoming better at speaking reveals the opportunity to link classroom studies with actual language use.

Also, students encounter a variety of international accents, dialects and conversational features that are usually lacking in standard classrooms. It helps students become more aware of language and culture which is important for talking to people in real life. The flexible nature of VoIP-based training helps students by making sure they get immediate guidance and their progress is checked regularly. Some learners do better in online programs because the atmosphere is more relaxed and accessible.

Suggestions on how to incorporate VoIP and Internet Telephony Tools into the curriculum

Internet telephony and VoIP tools should be meaningfully integrated into learning languages at schools after proper planning and teaching preparation. Teachers require instruction on how to use and teach with VoIP to guarantee proper use. Integrating traditional education methods with Internet voice tools (VoIP) can support the best learning results.

For example, voicing group chats, repeating how to pronounce words with partners, getting feedback from classmates and spending time chatting with others are all possible in sessions held outside the usual time for class. You can carry out storytelling, debating and acting out roles in your class and try out the virtual form as well. Asking learners to complete speaking tasks or join online join in lessons on their own boosts their motivation.

Also, using these platforms, learners can communicate with native speakers or other advanced peers in different cultures. Guaranteeing equal access to the necessary tools such as stable internet and the right devices is a responsibility of schools. joining forces with other countries' schools or cooperating online opens more opportunities to explore traditions and strengthen language.

Future Research Directions

Due to the encouraging findings, various other studies can be done to explore how VoIP and Internet telephony help language learning. Experiments conducted over periods of time should show if the gains in speaking continue and if longer VoIP communication helps people develop grammar, writing and comprehension skills.

Researchers need to focus on the way these tools differ in usage by people of all ages and skill levels. It could be studied if new users or children learn more than more experienced people from using technology. We should also find out which parts of language such as accent, grammar or vocabulary are affected by using VoIP software.

In addition to the above, the use of gamification and interactive features in VoIP systems needs attention. Things such as quizzes, badges and live challenges could be used as tools and looking at their outcomes could improve the creation of such tools. Study should also discover how these tools can be used in underprivileged regions that lack proper infrastructure and suggest practical solutions for scaling up.

In short, knowing how VoIP-based tools work across different classrooms is important for making sure their positive effects are available to all. With new advances in technology, educational methods also improve, giving students more interactive, fitted and situation-appropriate ways to learn languages.

Conclusion

Using Voice over Internet Protocol (VoIP) and Internet Telephony tools during English courses has played a big part in helping learners improve their speaking skills. Based on the outcomes, education tools help through adopting current methods in teaching, enhancing skills in speaking, reading and writing, along with having live communication abilities. Compared to formal schools, VoIP brings a lot of real-life communication into learning. They provide opportunities for students to have activities where they communicate with native speakers who speak various types of accents. Users noticed that their pronunciation, understanding of the language and ability to be clear improved and they also mentioned that their motivation had gone up and anxiety had gone down. Enjoying immediate feedback, using mobile devices for learning, flexible teaching schedules and always being guided made teachers positive. Technical analysis also points out that Zoom outperforms Google Meet as the latter has problems with people being unable to hear others speaking and with the audio being unclear, both of which are important for learning. Whereas traditional options are pre-planned by teachers and not very dynamic, VoIP solutions allow learners to proceed when ready, communicate with others, receive ongoing evaluations and not worry about step-by-step instructions. User assessment along with various statistical benefits from using VoIP technology in modern English classes proves how important and transformational VoIP technology has become. It is important that English as a Second Language (ESL) schools, as well as other types of educational institutions, use VoIP and Internet Telephony Technologies as core parts of their lessons to help students develop good English skills and stay interested.

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