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A STUDY ON THE EFFECTIVENESS OF AI-BASED TOOLS IN DEVELOPING COMMUNICATION SKILLS AMONG STUDENTS WITH HEARING IMPAIRMENT

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ABSTRACT

Artificial Intelligence (AI) has emerged as an innovative technological approach for improving the educational experiences and communication opportunities of students with hearing impairment. Communication is a fundamental component of learning, social interaction, academic achievement, and personality development. Students with hearing impairment may experience difficulties in understanding spoken language, developing speech, participating in classroom discussions, and interacting with hearing peers. Traditional communication-support strategies, including sign language, lip-reading, speech therapy, hearing aids, and written communication, play an important role in addressing these challenges. However, recent developments in AI-based technologies have introduced new possibilities for making communication more accessible, interactive, and individualized.

The present study aims to examine the effectiveness of AI-based tools in developing communication skills among students with hearing impairment. It focuses on the use of speech-to-text applications, automatic speech recognition, AI-powered captioning, text-to-speech systems, sign language recognition, intelligent communication applications, and AI-supported language-learning platforms. The study adopts a proposed quasi-experimental research design involving students with hearing impairment. Communication skills are considered in terms of receptive communication, expressive communication, vocabulary development, sentence formation, speech understanding, written communication, and social interaction. Pre-test and post-test assessments are proposed to evaluate changes in communication performance following an AI-supported instructional intervention. The paper

also discusses the opportunities and challenges associated with AI integration, including accessibility, affordability, language diversity, privacy, technological infrastructure, and teacher preparedness. It argues that AI-based tools can strengthen inclusive education when they are integrated with sign language, individualized educational planning, assistive technology, and appropriate teacher support. AI should complement rather than replace human interaction and established communication approaches.

KEYWORDS: Artificial Intelligence, Hearing Impairment, Communication Skills, Speech-to-Text, Automatic Speech Recognition, Sign Language Recognition, Assistive Technology, Inclusive Education.

1. INTRODUCTION

Education is a fundamental right of every individual, irrespective of physical, sensory, intellectual, or developmental differences. The primary objective of education is to provide equal learning opportunities and enable every learner to participate meaningfully in academic and social activities. Communication plays a central role in achieving these objectives because it allows students to express their thoughts, understand information, develop relationships, participate in classroom discussions, and acquire knowledge. For students with hearing impairment, communication may present particular challenges depending on their degree of hearing loss, age of identification, language background, access to assistive devices, and educational environment.

Hearing impairment refers to a reduction or loss of hearing ability that may affect an individual's capacity to perceive and understand sounds. Students with hearing impairment may experience difficulties in receiving spoken information, understanding classroom instructions, developing oral language, participating in group discussions, and communicating with teachers and classmates. However, it is important to recognize that hearing impairment does not indicate an inability to learn or communicate. With appropriate educational support, accessible communication systems, and assistive technologies, these students can develop effective communication skills and achieve their educational potential.

In conventional educational settings, students with hearing impairment use different communication approaches, including Indian Sign Language (ISL), speech, lip-reading, gestures, written language, hearing aids, cochlear implants, and other assistive listening devices. The selection of communication methods depends on individual needs and preferences. Teachers and special educators play an important role in providing

communication opportunities through visual teaching materials, demonstrations, interactive activities, and individualized educational planning.

However, conventional communication-support approaches may not always be sufficient in every classroom situation. For example, a student may find it difficult to follow rapid classroom conversations, understand unfamiliar vocabulary, participate in discussions involving multiple speakers, or communicate with individuals who do not know sign language. These challenges highlight the need for innovative technological solutions that support communication accessibility. Artificial Intelligence has created new opportunities for addressing communication barriers. AI refers to computer-based systems that perform tasks generally associated with human intelligence, such as recognizing speech, processing language, identifying patterns, translating information, and generating responses. AI-based communication applications can convert spoken language into written text, generate captions during classroom instruction, translate text into speech, and support certain forms of sign language recognition and language learning. For instance, automatic speech recognition applications can convert a teacher's spoken instructions into written text on a student's digital device. AI-powered captioning systems can display spoken classroom conversations as subtitles. Text-to-speech applications can convert written information into audible speech, while AI-supported language-learning platforms can provide vocabulary exercises, sentence-building activities, and personalized feedback. Another important development is the use of computer vision and machine learning in sign language recognition. These technologies attempt to identify hand movements, gestures, and facial expressions through cameras and convert recognized signs into text or speech. Such systems may provide additional communication opportunities, although their accuracy varies according to the sign language, vocabulary, regional variations, and technological conditions. In the Indian context, AI-based communication support has considerable relevance because students with hearing impairment come from diverse linguistic and educational backgrounds. Indian Sign Language is an important communication medium for many learners. The development of accessible digital resources, ISL learning platforms, speech-to-text applications, and multilingual educational technologies can support their participation in mainstream and special education environments.

The National Education Policy (NEP) 2020 emphasizes equitable and inclusive education and recognizes the importance of technology in improving educational access. Similarly, the Rights of Persons with Disabilities Act, 2016, provides a legal framework for promoting the rights, accessibility, and educational opportunities of persons with disabilities.

Against this background, the present study focuses on examining the effectiveness of AI-based tools in developing communication skills among students with hearing impairment. It aims to understand how technology-supported communication can improve receptive and expressive communication, language development, classroom participation, and social interaction.

1.1 Significance of the Study

The study is significant for the following reasons:

1. It explores innovative technological approaches for improving communication among students with hearing impairment.
2. It highlights the educational applications of AI-based communication tools.
3. It examines the potential of speech-to-text and automatic captioning in making classroom instruction accessible.
4. It emphasizes the importance of AI-supported vocabulary and language development.
5. It provides insights into the use of technology for improving classroom participation and peer interaction.
6. It may help special educators select appropriate assistive technologies according to individual student needs.
7. It contributes to the development of inclusive and technology-supported educational practices.

2. Review of Related Literature

The review of related literature provides a theoretical and research-based foundation for understanding the role of AI-based technologies in communication development among students with hearing impairment. Previous research has examined captioning, speech recognition, digital language-learning applications, sign language recognition, and assistive communication technologies. Artificial Intelligence has become an important component of educational innovation. AI-based educational systems can analyze learners' responses, provide individualized feedback, identify learning difficulties, and offer adaptive learning experiences. In inclusive education, these technologies can help reduce communication barriers and improve access to educational content for students with disabilities. Alkahtani (2024) examined the impact of artificial intelligence on the quality of life of deaf and hard-of-hearing students. The review analyzed 20 studies related to AI-enabled captioning, intelligent tutoring systems, social robots, interpreters, and assistive applications. The findings indicated that AI technologies have considerable potential to improve communication, educational

participation, independence, and inclusion. However, limitations associated with small sample sizes, insufficient longitudinal research, and technological accessibility were also identified. Speech-to-text technology uses automatic speech recognition to convert spoken language into written text. It is particularly useful for students with hearing impairment who experience difficulties accessing oral classroom communication. Teachers' instructions, classroom discussions, and educational explanations can be converted into digital text through speech recognition applications. Students can read the generated text on smartphones, tablets, computers, or display screens. Captioning services can also improve access to educational lectures and presentations. Alsalamah (2020) conducted a systematic review of captioning services for deaf and hard-of-hearing students in higher education. The review included seven studies and reported that most students benefited from captioning services. Improvements were observed in comprehension of lecture-related content after captioning support was provided. Sign language is an important communication system for many individuals with hearing impairment. It uses hand shapes, movements, facial expressions, and body movements to convey meaning. AI-based sign language recognition systems use computer vision, machine learning, and deep learning algorithms to identify gestures and convert them into text or speech. These technologies may help facilitate communication between sign language users and individuals who do not understand sign language. The 2023 survey A Survey on Sign Language Literature examined research on sign language recognition and translation. It highlighted the development of machine learning and vision-based approaches while identifying important challenges, including limited datasets, hardware requirements, and the shortage of practical applications. Similarly, recent research on deep learning-based sign language processing has explored the use of advanced computational models for recognizing and translating sign language. However, differences in sign language grammar, facial expressions, regional variations, and continuous signing remain important research challenges.

Online AI-powered captioning systems automatically generate written subtitles from spoken communication. These systems can support students with hearing impairment during lectures, discussions, seminars, and group activities. Zhang et al. (2024) investigated augmented reality captioning for deaf and hard-of-hearing students. Their study examined real-time speech-to-text captions through augmented reality smart glasses. The findings suggested that captioning could improve learning performance and active participation under appropriate conditions. However, the effectiveness depended on the quality and presentation of captions and the students' individual visual and auditory processing abilities.

aisel.aisnet.org The World Health Organization (WHO) emphasizes the importance of hearing technologies, speech and language therapy, sign language, captioning services, and other hearing assistive technologies in improving communication and participation. Although traditional hearing technologies are not necessarily AI-based, they can complement AI-supported communication systems. For example, a student using a hearing aid or cochlear implant may also benefit from classroom captioning, digital vocabulary support, and speech recognition applications.

2.1 Research Gap

The review of related literature indicates that AI-based technologies have considerable potential to improve communication accessibility for students with hearing impairment. Existing studies have examined captioning, speech recognition, sign language recognition, digital language applications, and intelligent learning systems.

However, several research gaps remain:

1. Limited experimental studies directly measure the improvement in different communication skills through AI-supported interventions.
2. There is a need for more research focusing on Indian Sign Language and Indian multilingual classroom environments.
3. The relationship between AI-supported vocabulary development and expressive communication requires further investigation.
4. Limited research has examined the combined effects of speech-to-text, captioning, and AI-supported language-learning applications.
5. More evidence is required regarding the long-term effectiveness of AI-based communication interventions.
6. There is a need to investigate the role of special educators in integrating AI-based tools into individualized educational programmes.

3. Objectives of the Study

The following objectives are proposed:

1. To study the effectiveness of AI-based tools in developing receptive communication skills among students with hearing impairment.
2. To examine the effectiveness of AI-based tools in improving expressive communication skills.

3. To investigate the impact of AI-based applications on vocabulary development and sentence formation.

4. To study the effectiveness of speech-to-text and AI-powered captioning in improving classroom communication.

4. RESEARCH METHODOLOGY

4.1 Research Design

The present study proposes a quasi-experimental research design to examine the effectiveness of AI-based tools in developing communication skills among students with hearing impairment. A pre-test and post-test control group design will be adopted. This design will help determine whether communication skills improve following the implementation of an AI-supported instructional programme.

Two groups will be considered:

1. Experimental Group: Students receiving communication instruction through AI-based tools along with regular educational support.
2. Control Group: Students receiving regular communication instruction without the planned AI-supported intervention.

Both groups will be assessed before and after the intervention. Their performance will be compared to determine the effectiveness of the AI-supported programme.

4.2 Population of the Study

The population will consist of students with hearing impairment studying in special schools, inclusive schools, and educational institutions offering special education programmes.

The study will focus on learners who require additional support in receptive and expressive communication, vocabulary development, sentence formation, and classroom interaction.

4.3 Sample and Sampling Technique

For the proposed investigation, a sample of 60 students with hearing impairment will be selected from educational institutions.

Group	Number of students
Experimental group	30
Control group	30
Total	60

A purposive sampling technique may be used to identify students who meet the inclusion criteria. Where feasible, participants should subsequently be randomly allocated to the experimental and control groups.

The following inclusion criteria may be adopted:

- Students with documented hearing impairment.
- Students within the selected age and educational levels.
- Students able to participate in the selected communication activities with appropriate accommodations.
- Students whose parents or guardians provide informed consent.

The sample should include learners with different communication preferences, including sign language, spoken language, written communication, or combined communication approaches.

4.4 Variables of the Study

Type of variable	Description
Independent variable	AI-based communication tools
Dependent variable	Communication skills
Supporting variables	Age, educational level, hearing status, language background, and previous technology experience

4.6 Duration of the Intervention

A proposed eight-week intervention programme will be implemented with the experimental group.

Week	Intervention activity	Communication focus
1	Introduction to AI tools	Familiarization and basic communication
2	Speech-to-text activities	Understanding spoken information
3	Live captioning exercises	Receptive communication
4	Digital vocabulary activities	Vocabulary development
5	Sentence formation exercises	Expressive communication
6	Sign language-supported activities	Sign-based communication
7	Group communication activities	Social interaction
8	Integrated communication practice	Overall communication development

The control group will receive regular communication instruction during the same period.

4.7 Tools for Data Collection

The following tools may be developed or selected for collecting relevant data:

1. Communication Skills Assessment Scale: To assess receptive and expressive communication, vocabulary, sentence formation, and social interaction.
2. Vocabulary Development Test: To measure recognition, understanding, and appropriate use of vocabulary.
3. Classroom Participation Observation Schedule: To record students' participation in classroom discussions and activities.
4. AI Tool Usage Record: To document the frequency, duration, and type of AI applications used.
5. Teacher Feedback Questionnaire: To obtain teachers' observations regarding students' communication development.

The assessment tools should be reviewed by special educators and experts in hearing impairment. Their reliability and validity should be established before the main investigation.

4.8 Procedure of Data Collection

The proposed data collection procedure will involve the following stages:

Stage 1: Pre-test Assessment

Both experimental and control groups will be assessed using the communication skills assessment scale. Initial scores will be recorded.

Stage 2: Implementation of Intervention

The experimental group will receive structured communication activities using AI-based applications. Teachers will demonstrate how to use speech-to-text, captioning, vocabulary-learning applications, and relevant sign language resources.

Stage 3: Classroom Practice

Students will participate in individual and group activities. They will practice understanding instructions, identifying vocabulary, constructing sentences, and communicating with teachers and peers.

Stage 4: Post-test Assessment

After eight weeks, both groups will be assessed again using the same or equivalent assessment instruments.

Stage 5: Data Analysis

Pre-test and post-test scores will be compared using appropriate statistical techniques to examine changes in communication skills.

4.9 Statistical Techniques

The following statistical techniques may be used:

- Mean and standard deviation to describe students' performance.
- Paired-samples t-test to compare pre-test and post-test scores within each group.
- Independent-samples t-test Effect size Percentage analysis to examine teachers' observations and students' participation.

5. RESULTS AND DATA ANALYSIS

Important research note: Since actual field data have not been supplied, the following numerical results are hypothetical and illustrative. They demonstrate how the findings of a proposed study involving 60 students could be presented. They must not be reported as actual experimental findings. The final research paper should replace these figures with data collected from the participants.

5.1 Analysis of Overall Communication Skills

The effectiveness of AI-based tools may be examined by comparing the pre-test and post-test communication scores of the experimental and control groups.

Table 1: Illustrative comparison of pre-test and post-test communication skills.

Group	N	Pre-test Mean	Post-test Mean
Experimental	30	42.35	72.60
Control	30	43.10	50.25

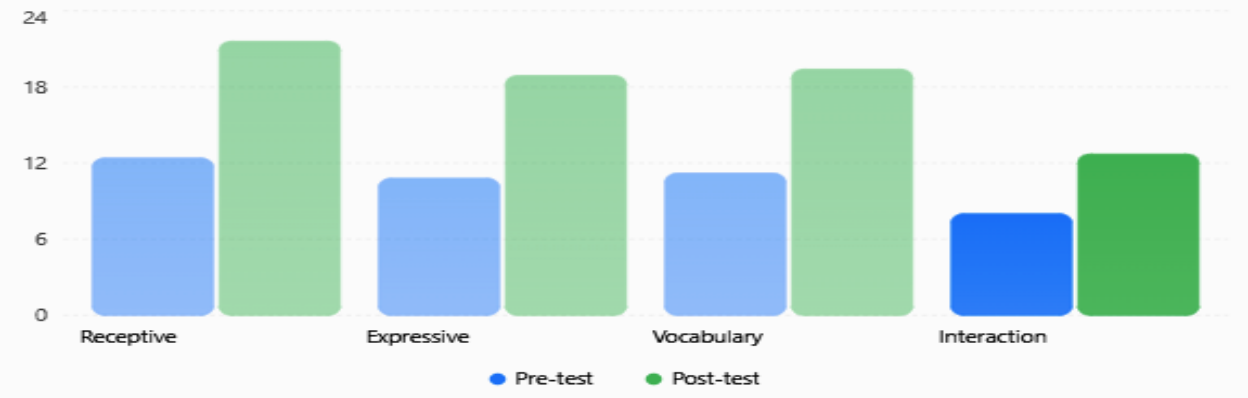
The illustrative findings indicate that the experimental group's mean communication score increased from 42.35 to 72.60, whereas the control group's mean score increased from 43.10 to 50.25. The experimental group demonstrated a greater improvement than the control group.

This difference suggests that structured AI-supported communication activities may provide additional opportunities for students to understand information, practice language, and participate in communication activities.

5.2 Analysis of Different Dimensions of Communication Skills

Table 2: Illustrative pre-test and post-test mean scores of communication dimensions.

Communication dimension	Pre-test	Post-test	Mean gain
Receptive communication	12.40	21.60	9.20
Expressive communication	10.80	18.90	8.10
Vocabulary development	11.20	19.40	8.20
Classroom interaction	8.00	12.70	4.70
Overall	42.40	72.60	30.20



5.3 Interpretation of Receptive Communication

Receptive communication refers to the ability to understand and interpret information received through speech, sign language, written language, gestures, and other communication methods.

Speech-to-text applications and live captioning may support receptive communication by providing written access to spoken classroom instructions. Students can read information at their own pace, revisit unfamiliar words, and connect written language with visual learning materials.

The illustrative increase in receptive communication scores suggests that AI-supported captioning and transcription may help reduce barriers to understanding classroom information.

5.4 Interpretation of Expressive Communication

Expressive communication involves the ability to convey thoughts, feelings, information, and ideas through speech, sign language, gestures, writing, or other communication systems.

AI-supported language applications may encourage students to construct sentences, practice vocabulary, and express their responses. Text-to-speech applications may also provide an additional communication channel for students who prefer written responses.

The improvement in illustrative expressive communication scores suggests that regular technology-supported practice may encourage learners to communicate more independently.

5.5 Interpretation of Vocabulary Development

Vocabulary development is essential for effective communication. Students need an adequate vocabulary to understand educational content, construct sentences, describe experiences, and interact with others.

AI-based vocabulary applications can provide pictures, written words, visual demonstrations, interactive exercises, and personalized feedback. Repeated practice may strengthen word recognition, comprehension, and appropriate vocabulary usage.

The illustrative findings show an increase in vocabulary scores from 11.20 to 19.40. This indicates the potential value of technology-supported vocabulary activities when they are appropriately structured.

5.6 Interpretation of Classroom Interaction

Classroom interaction includes responding to teachers, participating in group activities, asking questions, sharing information, and communicating with classmates.

Live captioning and digital communication applications may help students access classroom discussions. However, classroom interaction also depends on confidence, peer acceptance, teacher behaviour, communication preferences, and the availability of appropriate support.

The illustrative improvement indicates that AI tools may contribute to participation, but technology alone may not eliminate social and communication barriers.

6. DISCUSSION

The present study focuses on examining the effectiveness of AI-based tools in developing communication skills among students with hearing impairment. The proposed intervention combines speech-to-text technology, automatic captioning, sign language learning applications, text-to-speech systems, and AI-supported vocabulary activities.

The discussion is organized around the major dimensions of communication development.

6.1 AI-Based Tools and Receptive Communication

Receptive communication is an essential foundation for language development and academic participation. Students with hearing impairment may face difficulties in understanding spoken information, particularly when classroom instructions are delivered rapidly or when several individuals speak simultaneously.

AI-based speech recognition and captioning systems can convert spoken information into written text. This provides students with an additional visual communication channel.

For example, during a classroom lecture, a teacher may explain a concept verbally while a speech recognition application generates captions on a student's tablet. The student can read the captions and connect the information with diagrams, illustrations, and written notes.

This approach may improve access to information and reduce dependence on repeated verbal explanations. However, AI-generated captions may contain errors due to background noise, pronunciation differences, technical terminology, and multiple speakers. Therefore, teachers should verify important information.

6.2 AI and Expressive Communication Development

Expressive communication enables students to share their knowledge, opinions, emotions, and experiences. Students with hearing impairment may express themselves through sign language, spoken language, written language, or a combination of these methods.

AI-supported applications can provide opportunities for sentence construction, vocabulary practice, written expression, and interactive communication.

For example, a student may type a response into a text-to-speech application, which converts the written message into audible speech. Similarly, sign language learning applications can provide visual models for practicing signs.

These applications may increase opportunities for communication with individuals who have different communication preferences. Nevertheless, students should not be compelled to adopt speech-based communication when sign language or another communication method is their preferred mode.

6.3 AI-Based Tools and Vocabulary Development

Vocabulary is an important component of receptive and expressive language. Limited vocabulary may affect reading comprehension, sentence formation, academic achievement, and social communication.

AI-supported vocabulary applications can provide customized exercises based on students' learning levels. Pictures, animations, videos, and interactive questions can help connect words with their meanings.

For example, while teaching the word "environment", an application may display relevant pictures, provide the written word, demonstrate its meaning through visual content, and offer sentence-building exercises.

Such activities can provide multiple opportunities to learn and practice vocabulary. However, vocabulary development should be evaluated through actual comprehension and meaningful use rather than simple recognition of displayed words.

6.4 AI and Sign Language-Based Communication

Sign language plays an important role in the educational and social lives of many deaf learners. AI-based sign language technologies can support sign recognition, digital sign dictionaries, and interactive learning.

Computer vision systems may identify hand movements and selected signs through cameras. Machine learning algorithms can classify gestures and provide corresponding written or spoken outputs.

However, sign language is a complete linguistic system, not simply a collection of hand gestures. Facial expressions, body movements, spatial grammar, and contextual information contribute to meaning.

Consequently, current sign recognition applications should not be treated as complete substitutes for qualified sign language interpreters or fluent human communication partners.

For Indian students, AI applications should prioritize Indian Sign Language and be developed with deaf educators, ISL experts, and students with hearing impairment.

6.5 AI and Social Communication

Social communication involves initiating conversations, responding appropriately, maintaining interactions, expressing emotions, and participating in group activities.

Students with hearing impairment may experience communication barriers when their classmates and teachers are unfamiliar with their preferred communication methods.

AI applications may support communication by providing written transcripts, text-based conversations, and accessible educational content. These technologies can make communication more flexible and may encourage interaction between students with different communication backgrounds.

However, social communication is a human process involving empathy, emotional understanding, cooperation, and mutual respect. AI can facilitate communication but cannot replace meaningful human relationships.

6.6 Role of Special Educators

Special educators are essential for the successful implementation of AI-supported communication programmes.

They must identify individual communication needs, select suitable applications, provide systematic instruction, monitor progress, and ensure that technology is used meaningfully.

An effective special educator should:

- Assess individual receptive and expressive communication abilities.
- Identify the student's preferred communication method.
- Select accessible and age-appropriate AI applications.
- Integrate AI tools with Individualized Education Programmes (IEPs).
- Provide opportunities for practical communication.
- Monitor technological accuracy and student progress.
- Coordinate with parents, therapists, and classroom teachers.

AI should function as a supportive instructional resource rather than an independent replacement for professional teaching.

6.7 Challenges in Implementing AI-Based Communication Tools

Despite their potential, several challenges may affect the effective use of AI-based communication technologies.

1. Accuracy of Speech Recognition: Background noise, regional accents, unfamiliar vocabulary, and pronunciation differences may reduce transcription accuracy.
2. Limited Indian Sign Language Resources: AI-based sign language recognition requires sufficiently large, representative, and accurately annotated datasets. Such resources remain limited.
3. Economic Barriers: Some advanced AI applications, smartphones, computers, and internet services may be expensive for educational institutions and families.
4. Digital Literacy: Students, teachers, and parents may require training to use AI applications effectively.
5. Privacy and Data Security: Applications involving microphones, cameras, and personal information may raise privacy concerns. Educational institutions should ensure informed consent and appropriate data protection.
6. Individual Differences: Students differ in their hearing levels, language backgrounds, educational experiences, and communication preferences. A single AI application may not be appropriate for everyone.
7. Technological Dependence: Excessive dependence on digital communication may reduce opportunities for direct human interaction if the technology is not integrated thoughtfully.

These challenges indicate that AI-based communication programmes must be accessible, affordable, culturally appropriate, and supported by trained professionals.

7. Major Findings of the Study

On the basis of the theoretical review and the illustrative data analysis, the following potential findings are identified. These should be treated as expected findings until verified through actual data collection.

1. AI-based communication tools may improve receptive communication by providing written access to spoken information.
2. Speech-to-text applications may help students understand classroom instructions and discussions.
3. AI-supported vocabulary applications may improve word recognition, comprehension, and vocabulary usage.
4. Text-to-speech applications may provide additional opportunities for students to express their thoughts and responses.
5. Sign language learning applications may support visual vocabulary development and communication practice.
6. AI-powered captioning may improve students' access to classroom information.
7. Structured AI-supported activities may encourage classroom participation and peer interaction.
8. Teacher guidance and individualized support may influence the effectiveness of AI-based communication tools.
9. Accessibility, cost, technological accuracy, and digital literacy may affect the implementation of AI-supported communication programmes.
10. AI-based tools are likely to be most useful when integrated with established special education practices and students' preferred communication methods.

8. RECOMMENDATIONS

On the basis of the proposed research framework, the following recommendations are suggested for educational institutions, special educators, policymakers, parents, and technology developers.

8.1 Integration of AI into Inclusive Classrooms

Schools should incorporate appropriate AI-based communication tools into inclusive classroom practices. Speech-to-text applications, live captioning, and accessible digital learning resources should be provided according to individual student requirements.

8.2 Development of Indian Sign Language-Based AI Applications

There is a need to develop reliable AI applications that support Indian Sign Language recognition, learning, and communication. These applications should involve deaf community members, sign language experts, and special educators during development and evaluation.

8.3 Training of Special Educators

Special educators should receive professional development in AI literacy, speech recognition, digital accessibility, captioning applications, and AI-supported language instruction.

8.4 Individualized Communication Support

AI applications should be selected according to the communication abilities, language background, age, and preferences of individual learners. Technology should be integrated into IEP goals rather than implemented as a uniform programme.

8.5 Affordable and Accessible Technology

Government institutions and educational organizations should promote affordable AI-based communication applications and provide suitable devices and internet facilities to students from economically disadvantaged backgrounds.

9. Educational Implications

The present study has important implications for special education and inclusive educational practices.

First, it highlights the possibility of using AI-based technologies to create accessible communication environments. Second, it encourages teachers to adopt innovative teaching approaches that combine visual, textual, and digital resources.

Third, the study emphasizes the importance of individualized communication instruction. Students with hearing impairment should be provided with learning opportunities that respect their communication preferences and individual abilities.

Fourth, AI-based communication tools may support the implementation of inclusive education policies by improving access to classroom information and learning activities.

Finally, the study may contribute to the development of technology-supported educational programmes aligned with the objectives of NEP 2020 and the Rights of Persons with Disabilities Act, 2016.

10. CONCLUSION

Artificial Intelligence has significant potential to improve communication opportunities for students with hearing impairment. The development of speech-to-text applications, automatic captioning, text-to-speech systems, sign language learning platforms, and AI-supported vocabulary applications has created new possibilities for accessible and inclusive education.

The present study proposes an examination of AI-based communication tools through a structured intervention focusing on receptive communication, expressive communication, vocabulary development, sentence formation, and classroom interaction. The reviewed literature indicates promising applications of captioning, digital language-learning resources, and AI-supported communication technologies. However, their effectiveness depends on the accuracy of the technology, the educational context, individual student needs, and the quality of teacher support.

AI-based tools can help students access spoken information, practice vocabulary, communicate their ideas, and participate in classroom activities. At the same time, technological limitations, economic barriers, privacy concerns, and the lack of adequate Indian Sign Language resources require serious consideration.

It is important to recognize that AI cannot independently fulfil all the communication and educational needs of students with hearing impairment. Human interaction, sign language, individualized instruction, emotional support, and professional guidance remain essential components of effective education.

Therefore, AI should be considered a complementary educational resource that strengthens existing communication approaches rather than replacing them. The integration of AI with assistive technology, sign language, inclusive pedagogy, and individualized educational planning can contribute to creating accessible, participatory, and equitable learning environments for students with hearing impairment.

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