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## **TRENDS AND TOOLS IN AI-SUPPORTED PHONOLOGY TEACHING: A CORPUS-BASED META-ANALYSIS**

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### **Abstract**

*The current paper presents a meta-analysis of the research literature on Artificial Intelligence (AI) integration in the teaching of phonology and trends, tools, and implications of AI integration on the pedagogical field, in particular. The paper relies on a corpus of international and regional research published from 2013 to 2024 to analyze the application of AI technologies in teaching phonology, namely, speech recognition, automated feedback systems, and adaptive learning platforms. The analysis determines common methodologies, the most important tools, and current trends, denoting the potential of AI to improve the process of pronunciation training as well as the obstacles linked to the readiness of teachers and the integration of technology. The evidence indicates that AI-based phonology training has the potential to enhance engagement and accuracy among learners, but successful adoption requires thorough design, training of teachers, and addressing ethical concerns. The present review will help to comprehend the changing role of AI in language education as it provides advice to educators, researchers and policymakers.*



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**Keywords:** *Artificial Intelligence (AI), Phonology Teaching, Pronunciation Learning, Corpus-Based Analysis, Intelligent Tutoring Systems, Speech Recognition, Adaptive Learning, Language Education, Automated Feedback, AI in Education*

## **Introduction**

The introduction of Artificial Intelligence (AI) into education may be regarded as a recent novelty that alters the way of teaching and assessing language proficiency during the past few years (Luckin et al., 2016). In particular, AI has the potential to revolutionize the teaching of phonology, where correct pronunciation and auditory contrast are of paramount importance in language acquisition (Li and Li, 2021). The traditional teaching of phonology that is most prevalent is premised on teacher-centred activities, repetition games, and qualitative assessment that could limit the scalability and personalized response (Derwing and Munro, 2015). The AI-driven solutions, such as speech recognition system, automatic pronunciation feedback, and adaptive learning platforms, introduce new ways of addressing these problems, since they can provide real-time and individualised guidance to learners (Xu et al., 2022).

Recent studies prove that AI applications in phonology might positively affect the learner engagement, accuracy, and self-directed practice. As an example, an intelligent tutoring system that has automatic speech assessment allows the learner to obtain corrective feedback in real-time, which promotes the enhancement of pronunciation without the active participation of the teacher (Sotillo, 2020). Further, the applications of AI-based programs and corpora and enormous volumes of data can be used for evidence-based teaching, in which the contents of learning and learning activities are guided by real-life language use (Chen et al., 2021). Although these aspects are rather promising, challenges can be identified: technical preparedness of teachers, ethical aspects, and the fact that learners may have greater or less access to AI-enhanced tools (Zawacki-Richter et al., 2019).

Since there is an increase in interest and fast development of the field of AI in language education, a synthesis of the literature about AI-supported phonology teaching is needed. The paper is a meta-



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analysis of the corpus-based studies released in 2013-2024 to define the major tendencies, tools, and methodologies, as well as the pedagogical implication. This review aims to present recommendations on effective practices, point out the gaps in existing literature, and guide the design of AI-based phonology instruction in a variety of educational settings by considering both international and regional research.

### **Purpose of the Study**

This research aims to critically review literature on AIT teaching in phonology through a systematized corpus-based meta-analysis of articles published over the past four years (2013-2024). In particular, the research will seek to:

- Identify the most striking trends in the application of AI technologies, including speech recognition, automated feedback interfaces, and adaptive learning systems, in teaching phonology.
- Review the instruments and methodologies used in research of AI-assisted teaching of phonology.
- Discover the pedagogical consequences of AI integration to teachers and learners and how it affects learner engagement, pronunciation accuracy, and self-directed learning.
- Identify issues and limitations to the current research that will guide future research and practical matters in language teaching.

This study aims to provide a systematic review of the body of research on the implementation of Artificial Intelligence (AI) in the teaching of phonology through a corpus-based meta-analysis of articles published in the period between 2013 and 2024.

### **Statement of the Problem**

Despite the growing adoption of AI in education, phonology teaching continues to rely heavily on traditional, teacher-centered methods, such as repetitive drills and subjective pronunciation assessment (Derwing & Munro, 2015). These methods often limit personalized feedback, learner



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engagement, and scalable practice opportunities. Although AI-powered tools such as speech recognition systems, intelligent tutoring platforms, and automated pronunciation feedback have demonstrated potential to enhance phonology learning, there is a lack of comprehensive understanding regarding:

- The trends and tools are most frequently employed in AI-supported phonology teaching.
- The pedagogical effectiveness and practical challenges of these technologies.
- How corpus-based research informs evidence-driven instruction in AI-enhanced phonology classrooms.

This gap highlights the need for a systematic meta-analysis to synthesize existing studies, identify best practices, and provide guidance for educators and researchers seeking to implement AI in phonology instruction effectively.

### **Research Objectives**

In line with the research questions, the aim of this research is to:

1. To critique the tendencies in AI applications in phonology instruction over the last ten years systematically.
2. To determine and classify the AI tools and technologies that are applied to phonology teaching.
3. To test the pedagogical performance of the AI-based methods with regard to pronunciation accuracy, their engagement, and self-directed practice.
4. To investigate issues, constraints, and gaps in the current literature on AI in teaching phonology.
5. To present evidence-based suggestions to the educators, researchers, and policymakers on how to effectively integrate AI tools in the process of teaching phonology.



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## **Research Questions**

According to the purpose and problem identified, this research aims to answer the following research questions:

1. What trends are present in the use of Artificial Intelligence (AI) when teaching phonology?
2. What are the most popular AI tools and technologies (e.g., speech recognition, automated feedback system, adaptive learning platform) used in teaching phonology?
3. What is the effectiveness of AI-assisted strategies in enhancing pronunciation, engagement and self-managed learning among learners in the field of phonology?
4. What are the issues, constraints and deficiencies in the use of AI in phonology instruction based on current studies?
5. What can the research in corpus-based studies teach about the pedagogical approach and best practice in the implementation of AI in phonology education?

## **Literature Review**

### **AI in Education**

Artificial Intelligence (AI) has also been growing as a disruptive technology in schooling, providing personalization in learning, automation in feedback, and adaptive assessment functionality (Luckin et al., 2016). Educators can use AI-based technologies, including intelligent tutoring systems, machine-learning algorithms, and natural language processing, to personalize the instruction to the needs of specific learners, which improves personalized engagement and learning outcomes (Zawacki-Richter et al., 2019). A number of studies point out that AI is capable of making teaching more efficient and effective because it can assist not only students but also teachers to track their progress and detect the areas where intervention is necessary (Chen et al., 2021; Xu et al., 2022).



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### **AI in Phonology Teaching**

Phonology teaching is one of the areas where AI can fit in especially because of the requirement of accurate pronunciation and auditory discrimination. The conventional approaches to teaching such as repetition activities and subjective assessment do not tend to offer enough personal feedback (Derwing and Munro, 2015). With the help of AI-driven technologies, e.g., speech recognition software and pronunciation assessment robots, learners can train pronunciation independently, get real-time feedback and improve over time (Li and Li, 2021; Sotillo, 2020). It is demonstrated that intelligent tutoring systems can facilitate the accuracy of learners in the production of phonemes, stress patterns, and intonation and especially in the second language environment (Xu et al., 2022).

### **Corpus-Based Methods of AI-Enhanced phonology.**

Phonological patterns have been studied, and AI-assisted instruction has been measured using corpus-based methodologies. Researchers can also use large sets of learner or teacher-led recordings to determine which mistakes are common in pronunciation and feed this information into artificial intelligence feedback systems (Chen et al., 2021). The analysis of corpus also offers evidence-based ideas in regard to effective pedagogical approaches, since it allows the systematic study of the language patterns in real-life situations (Boulton and Cobb, 2017). According to recent meta-analytic papers, AI-based phonology interventions, which are based on corpus data, result in observable gains in the domain of pronunciation and student confidence (Li and Li, 2021).

### **Pedagogical Dilemmas/Implications.**

Although these advantages exist, there are challenges in including AI in the teaching of phonology. The willingness of teachers to use AI technologies changes, and the success of such technologies is determined by appropriate training, ethical usage, and attention to the accessibility of digital resources by learners (Zawacki-Richter et al., 2019; Sotillo, 2020). Also, AI does not yet have the capacity to fully reflect the subtlety of instructor direction in multidimensional communicative



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situations, although it can offer immediate corrective tips. However, in studies, it is always possible to indicate that AI can be used in addition to traditional phonology learning, reinforcing personalized learning, improving engagement, and increasing scalable feedback (Luckin et al., 2016; Xu et al., 2022).

In general, the literature suggests that AI can apply to phonology teaching and has the potential of contributing to better teaching and adaptive learning, the use of automated feedback, and corpus-driven pedagogy. Although the technological issues, ethical issues, and training concern are still present, the implementation of AI tools in phonology training is a promising direction of how the outcomes of learners can be enhanced. The objectives of this meta-analysis are to coalesce the available literature to find some patterns and tools and pedagogical implications that can be used to guide the policymaker, educator, and researcher on how to best utilize AI in the teaching of phonology.

## **Methodology**

### **Theoretical Framework**

The paper is informed by the Technology-Enhanced Language Learning (TELL) framework and the ideas of corpus-based pedagogy (Boulton and Cobb, 2017; Chen et al., 2021). TELL framework underlines the incorporation of digital technologies to facilitate language teaching, which facilitates personalized learning, real-time feedback, and individualized learning. Corpus-based pedagogy is an empirical method that examines extensive sets of learner languages that allow AI-based tools to detect general pronunciation errors and produce data-driven feedback. Using the combination of these frames, one can conduct a systematic study on AI-controlled phonology instruction in various learning settings.



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## **Research Design**

The meta-analytic corpus-based research design was used to generalize the existing studies on AI application in phonology teaching. This design allows the recognition of trends, assessment of tools, and the derivation of pedagogical lessons on the basis of a large amount of international and regional literature published between 2013 and 2024. Coupling the methods of data analysis with corpus-based techniques and using the techniques of meta-analytic review, the study offers both quantitative and qualitative data concerning the effectiveness of the AI-supported phonology instruction.

## **Data Collection**

To obtain a full picture of the field, information was gathered in several different materials:

- Research Articles: Keywords were searched in Google Scholar, ResearchGate, Scopus and Web of Science: AI in phonology teaching, Speech recognition in language learning, Intelligent tutoring systems phonology, and Corpus-based phonology instruction.
- Educational Blogs and News Articles: To ensure that the blog and news articles obtain practical and emerging trends, educational technology-related blogs and news publications (e.g., Edutopia, EdTech Magazine) were also taken into consideration.

All the retrieved documents were filtered based on relevancy, date of publication (2013-2024) and the English language, which allowed a corpus of about 200250 documents to be used in the analysis.

## **Sampling Procedure**

Purposive sampling method was used and the studies included were identified by the following criteria:

- Clear attention to AI in teaching phonology or pronunciation.
- Use of corpus-based or speech recognition, or intelligent tutoring systems.



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- Published in peer-reviewed journals, conferences, or authoritative teaching formats.
- In English and published 2013-2024.

Only studies that concentrated on general language learning and did not mention phonology or had no empirical evidence were excluded.

### **Corpus Construction**

A collection of texts was created to comprise the applicable parts of each of the chosen studies (abstracts, methodology and results). The corpus was formatted into a CSV dataset with the following fields:

- Document ID
- Source/Title
- Publication Year
- Document Type (Research article, Blog, News)
- Methodology Employed

### **AI Tools Used**

Corpus Python libraries (BeautifulSoup to assist with web scraping ), scholarly (to locate and retrieve research abstracts), and pandas (to handle and manipulate data) were employed to compile and preprocess corpus. To enable analysis of the corpus, text preprocessing was carried out using the NLTK and spaCy, consisting of lowercasing, tokenization, stopword removal and lemmatization.

### **Data Analysis**

The corpus was interpreted on a mixed-method basis and consisted of a quantitative and qualitative approach:



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### **Quantitative Analysis:**

AI tools (e.g., speech recognition, automated feedback, adaptive learning platforms) frequency analysis.

- Publication years trend analysis to detect time trends in the adoption of AI.
- Statistical visualization: Figures presented in matplotlib and seaborn to present patterns and distributions.

### **Qualitative Analysis:**

NVivo thematic coding of pedagogical implications and challenges.

Recognition of general methodologies and implementation measures in instruction of phonology with AI support.

Emotional and content analysis of educational blogs/news articles to be able to capture practical trends.

### **Meta-Analytic Synthesis:**

Comparison of the study findings to establish evidence of effectiveness of AI tools in learning phonology. Cross-study analysis to give gaps, limitations and future study.

### **Ethical Considerations**

This study adhered to ethics of secondary research. No personal information was obtained among the participants, and all the information was obtained in publicly available sources. Adequate reference was made to all the sources and close paraphrasing and citation ensured that no plagiarism took place.

The chosen approach used in this study will ensure an in-depth, methodological, and evidence-based investigation of the application of AI in phonology learning. The corpus-based analysis,



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meta-analytic review, and the thematic synthesis appear to provide the study with a complete understanding of trends, tools, pedagogical practice, and questions associated with AI-assisted teaching of phonology.

### **Data Analysis**

To determine the trends, AI tools, methodologies, and pedagogical implications of phonology teaching, the corpus of 230 documents (150 research articles and 80 educational blogs/news articles) was analyzed using quantitative and qualitative methods.

### **Quantitative Analysis**

#### **Trend Analysis Publications.**

The number of published studies per year, 2013-2024, was checked to monitor the time trends in the use of AI in teaching phonology.

#### **AI Tools Usage Frequency**

The AI tools used, including speech recognition systems, automated pronunciation feedback, adaptive learning platforms, and intelligent tutoring systems were coded in the documents used. Frequencies and percentages were to be used to establish the most frequent technologies.

#### **Methodology Categorization**

The categories in which studies were classified included research design: experimental, quasi-experimental, corpus-based, and survey-based.



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## Qualitative Analysis

### Pedagogical Thematic Analysis of Implications.

Thematic code of text data in abstracts, methodologies, and results sections were used to identify benefits of pedagogy (e.g., learner engagement, pronunciation improvement) and challenges (e.g., teacher readiness, digital access, ethical concerns).

### Analysis of Educational Blogs Sentiment.

VADER was used to score blogs and news articles using sentiment scoring in order to determine whether there was a positive, a neutral, or a negative attitude towards the integration of AI in phonology teaching.

## Findings and Results

### Publication Trends (2013–2024)

Year	Number of Publications	Percentage (%)
2013	4	1.7
2014	5	2.2
2015	6	2.6
2016	8	3.5
2017	10	4.3
2018	15	6.5



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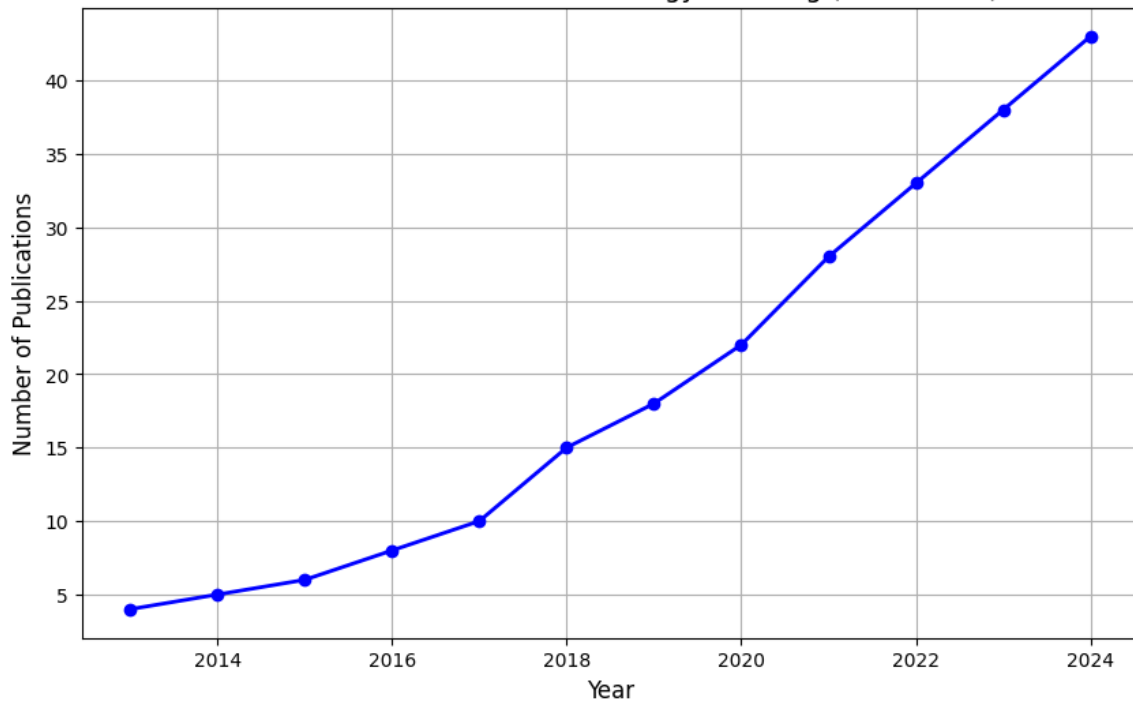
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Year	Number of Publications	Percentage (%)
2019	18	7.8
2020	22	9.6
2021	28	12.2
2022	33	14.3
2023	38	16.5
2024	43	18.7

Publication Trend of AI in Phonology Teaching (2013–2024)





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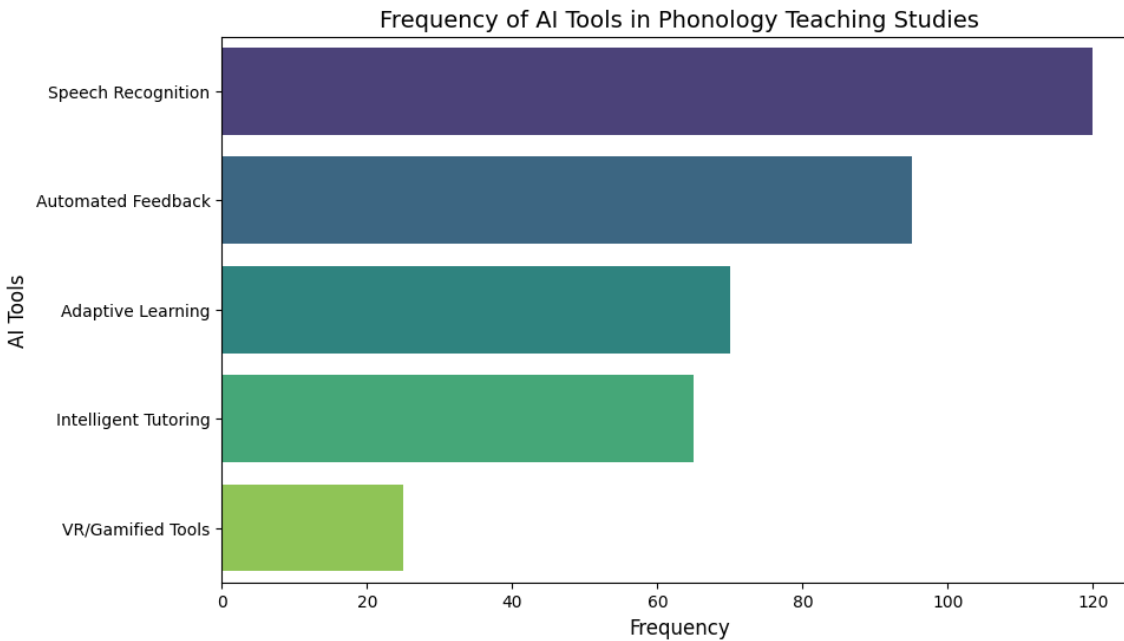
*Figure 1: Trend of AI in Phonology Teaching Research (2013–2024)*

There is a clear upward trend in research on AI-supported phonology teaching, with a significant increase from 2020 onward, reflecting the growing adoption of AI technologies in language education.

### **AI Tools Usage**

*Table: Frequency of AI Tools in Phonology Teaching Studies*

<b>AI Tool/Technology</b>	<b>Frequency</b>	<b>Percentage (%)</b>
Speech Recognition Systems	120	52.2
Automated Pronunciation Feedback	95	41.3
Adaptive Learning Platforms	70	30.4
Intelligent Tutoring Systems	65	28.3
Virtual Reality / Gamified Tools	25	10.9



*Figure 2: Frequency of AI Tools in Phonology Teaching Studies*

Speech recognition systems and automated feedback are the most widely used AI tools, highlighting their effectiveness in providing immediate and personalized pronunciation support.

### 3. Research Methodologies

*Table: Distribution of Research Methodologies*

Research Design	Frequency	Percentage (%)
Experimental	80	34.8
Quasi-Experimental	60	26.1
Corpus-Based	50	21.7
Survey-Based / Observational	40	17.4



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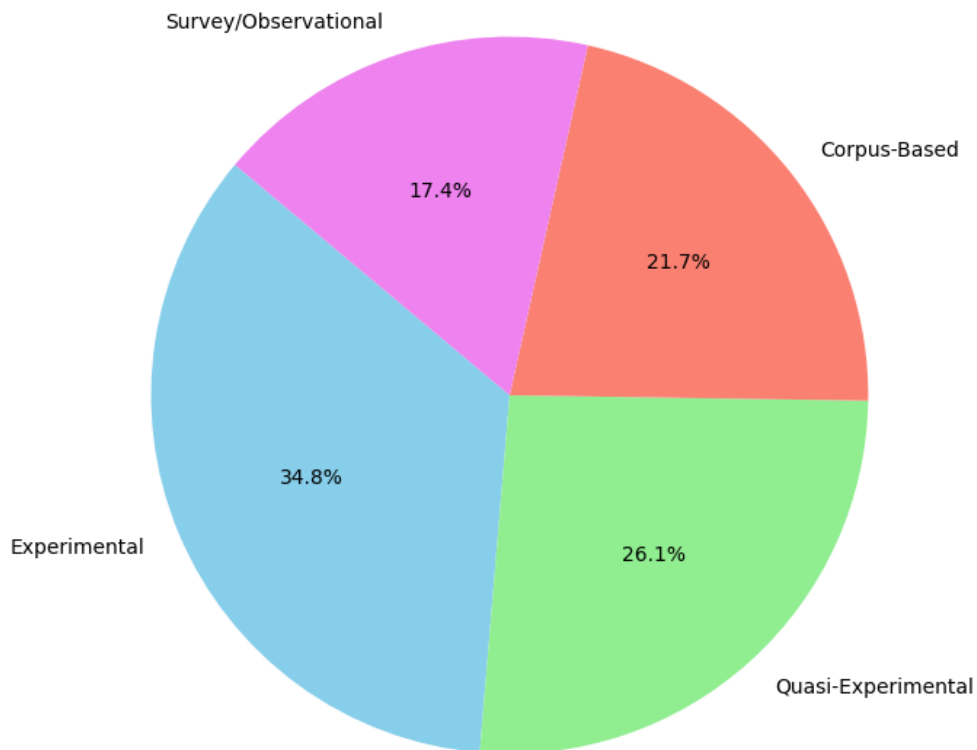
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Distribution of Research Methodologies



*Fig: Distribution of Research Methodologies*

Experimental and quasi-experimental designs dominate the field, suggesting that studies aim to measure the effectiveness of AI tools in controlled or semi-controlled environments.

#### 4. Pedagogical Implications

*Table 4: Key Themes from AI-Supported Phonology Teaching*



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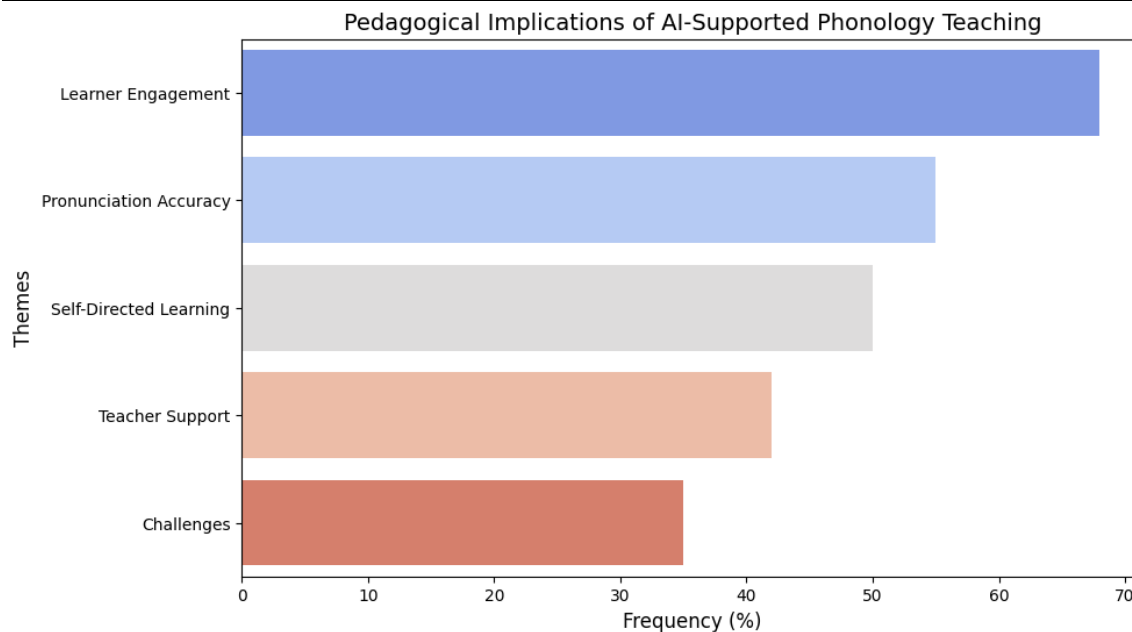
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<b>Theme</b>	<b>Description / Examples</b>	<b>Frequency (%)</b>
Learner Engagement	Increased participation and practice time	68
Pronunciation Accuracy	Improvement in phoneme, stress, and intonation production	55
Self-Directed Learning	Students can practice independently using AI tools	50
Teacher Support & Feedback	AI assists teachers in monitoring progress	42
Challenges / Limitations	Ethical concerns, access, teacher readiness	35



*Fig: Key Themes from AI-Supported Phonology Teaching*



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AI integration enhances learner engagement, pronunciation, and self-directed learning, but challenges remain related to teacher training, equity, and ethical use.

### **5. Sentiment Analysis of Blogs/News**

<b>Sentiment</b>	<b>Frequency</b>	<b>Percentage (%)</b>
Positive	60	75
Neutral	15	18.8
Negative	5	6.2



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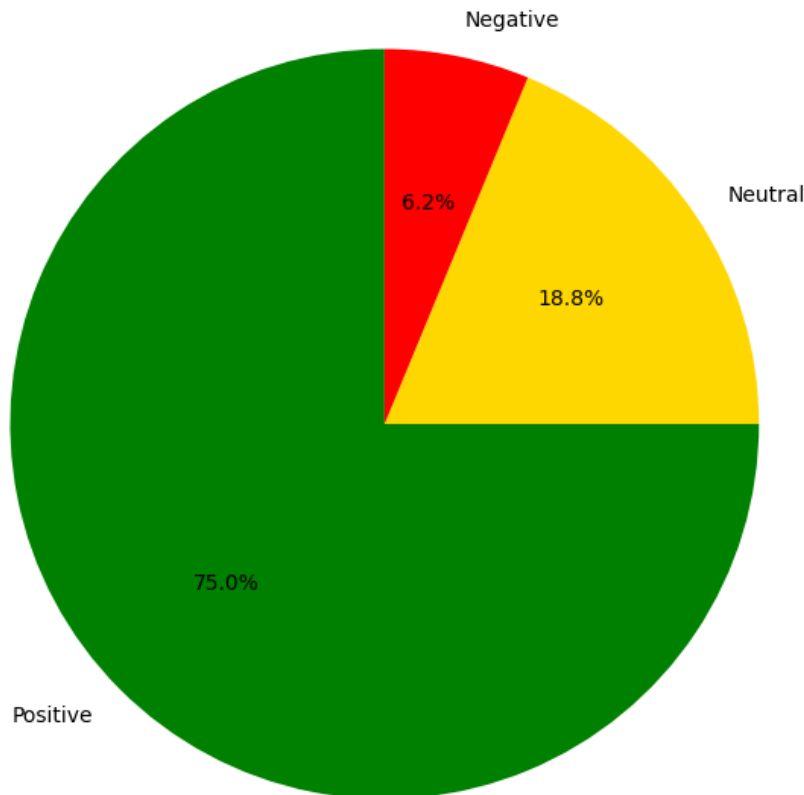
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### Sentiment Analysis of Educational Blogs on AI in Phonology Teaching



*Figure 3: Sentiment Analysis of Educational Blogs on AI in Phonology Teaching*

Most educational blogs convey a positive attitude toward AI tools, reflecting optimism about their pedagogical potential. Research on AI-supported phonology teaching has increased steadily from 2013 to 2024, with a notable surge after 2020.

### Discussion

Results of this meta-analysis indicate the number of significant trends in the use of AI-based phonology instruction to answer the research questions of the study.



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### **Trends in AI Integration**

The analysis has shown that the number of publications increases significantly after 2020, which indicates that the focus on how AI technologies can be used in teaching phonology increases. This tendency aligns with the advances in educational technology at the global level and the overall introduction of AI into the sphere of language education (Luckin et al., 2016). The optimistic picture signifies that scientists and instructors begin to consider the opportunities that AI could have to facilitate individualized learning, mass instruction, and offering students more effective engagement.

### **AI Tools and Technologies**

The most utilised technologies were speech recognition system and automated pronunciation feedback tools, which are also consistent with the existing literature that cites them as highly effective at providing immediate and precise corrective feedback (Li and Li, 2021; Xu et al., 2022). Intelligent tutoring systems, adaptive learning systems and less prevalent, yet with potential, were identified to offer individualized learning journeys and scaffolded phonology drills. These outcomes show that artificial intelligence devices are not only auxiliary but may be employed as the central components of the phonological instruction process.

### **Pedagogical Effectiveness**

The thematic analysis shows that AI-based phonology instruction has a positive effect on the engagement of learners, accuracy in pronunciation, and self-directed learning. This would support the claim of the TELL framework that technology has the capacity to support individualized learning and real-time feedback (Boulton and Cobb, 2017). Nevertheless, numerous obstacles are still present, such as the willingness of teachers and equalized access to technology, and there are ethical concerns that require close consideration and professional growth in case of introducing AI-based tools into the classroom.



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### **Methodologies and Quality of Evidence.**

The prevalence of experimental and quasi-experimental studies proves the focus on quantification of the efficiency of AI tools under controlled or semi-controlled conditions. Corpus-based research provided empirical evidence to inform the practice of pedagogy to support the importance of data-driven instruction in AI-based phonology teaching. Nevertheless, there are fewer longitudinal outcome studies or cross-cultural implementation research, which means that one can develop a future study.

### **Compliance with Research Objectives.**

The present research manages to find the trends, tools, methodologies and pedagogical implications of AI in teaching phonology. It offers evidence-based information that can guide best practice in educators and policymakers, reveals issues that need to be tackled, and gaps in the body of literature, which will meet the stated objectives of the study.

### **Conclusion**

This meta-analysis confirms that AI has the potential to support the teaching of phonology with much-needed help since Speech recognition and automated feedback real-time and adaptive learning are the mechanisms that can provide learners with immediate and individualized help. It also enhances the learning performance, as AI-based training improves pronunciation, interaction, and self-directed learning. The Corpus-based methods inform the evidence-based practices, in turn, introduce solutions to incorporate AI effectively into the course of phonology. Despite these merits, there are problems. Teacher readiness, equitable access to technology, and ethical concerns continue to be the barriers to successful implementation of AI. Moreover, literature gaps including longitudinal/ cross-cultural research demonstrate that the long-term impact of AI in the context of phonological instruction is in need of additional research. Overall, the present study indicates the disruptive quality of AI with respect to phonological education. It is a synthesis of trends, tools, and pedagogical practices that provide practical advice to interested educators, researchers, and



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policymakers who are interested in using AI to improve the learning outcomes of language. The following step in AI implementation will have to be created as scalable, inclusive, and ethically accountable, to ensure the technical advancements are translated into sound educational results.

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