# Artificial Intelligence in English Phonology: Improving Pronunciation and Speech Recognition for Iraqi Universities' Students

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## Abstract

This study investigates the role of Artificial Intelligence (AI) applications in improving English phonology, pronunciation, and speech recognition among Iraqi universities' learners of English as a Foreign Language (EFL), since despite significant emphasis on grammar and vocabulary in Iraqi universities' higher education, phonological competence remains underdeveloped and continues to hinder oral communication and intelligibility· The research specifically focuses on undergraduate students from the University of Baghdad, Al-Mustansiriyah University, and Al-Mansour University College, where persistent difficulties with segmental sounds such as /θ/, /ð/, and /ʒ/, as well as suprasegmental features including stress, rhythm, and intonation, have been documented· Using a quasi-experimental design, the study integrates AI-powered tools such as Google Speech Recognition, ELSA Speak, and YouGlish to enhance learners' exposure to authentic speech models, provide real-time feedback, and develop pronunciation accuracy, with data collected from 120 students (60 in the experimental group and

60 in the control group) over a 12-week intervention period· Pre-test and post-test assessments, conducted through acoustic analysis with Praat software alongside expert phonological evaluation, measured improvements in vowel and consonant production, prosodic accuracy, and overall speech intelligibility· Findings indicate that the experimental group demonstrated significant progress in reducing common phonological errors, particularly in the substitution of /p/ with /b/, the devoicing of final consonants, and the misplacement of primary stress in polysyllabic words, while the integration of AI tools also enhanced learner motivation and self-confidence, lowering the anxiety often associated with oral communication in English·

Keywords :Artificial Intelligence (AI), English Phonology, Speech Recognition, Pronunciation Accuracy, EFL Learners, Technology-Enhanced Language

الملخص

تبحث هذه الدراسة دور تطبيقات الذكاء الاصطناعي في تحسين علم الأصوات الإنجليزية والنطق والتعرف على الكلام لدى متعلمي اللغة الإنجليزية كلغة أجنبية في الجامعات العراقية، حيث أنه على الرغم من التركيز الكبير على القواعد والمفردات في التعليم العالي في الجامعات العراقية، إلا أن الكفاءة الصوتية لا تزال غير متطورة، مما يعيق التواصل الشفهي وفهم الكلام. ويركز البحث تحديدًا على طلاب المرحلة الجامعية الأولى من جامعة بغداد، وجامعة المستنصرية، وكلية المنصور الجامعية، حيث تم توثيق صعوبات مستمرة في نطق الأصوات القطعية مثل /θ/ و /ð/و/ʒ/، بالإضافة إلى السمات فوق القطعية كالنبر والإيقاع والتنغيم. وباستخدام تصميم شبه تجريبي، تدمج الدراسة أدوات مدعومة بالذكاء الاصطناعي مثل Google Speech Recognitionو ELSA Speakو YouGlishلتعزيز تعرض المتعلمين لنماذج الكلام الأصلية، وتوفير تغذية راجعة فورية، وتطوير النطق. تم قياس دقة البيانات التي جُمعت من ١٢٠ طالبًا (٦٠ في المجموعة التجريبية و٦٠ في المجموعة الضابطة) على مدار فترة تدخل استمرت ١٢ أسبوعًا. وقد تم إجراء تقييمات قبلية وبعدية، من خلال التحليل الصوتي باستخدام برنامج Praat إلى جانب التقييم الصوتي من قبل خبراء، لقياس التحسينات في إنتاج حروف العلة والحروف الساكنة، ودقة النبر، ووضوح الكلام بشكل عام. وتشير

النتائج إلى أن المجموعة التجريبية أظهرت تقدمًا ملحوظًا في الحد من الأخطاء الصوتية الشائعة، لا سيما في استبدال /p/ بـ/b/ ، وإلغاء صوت الحروف الساكنة النهائية، وموضع النبرة الأساسية في الكلمات متعددة المقاطع، في حين أن دمج أدوات الذكاء الاصطناعي قد عزز أيضًا من دافعية المتعلمين وثقتهم بأنفسهم، مما قلل من القلق الذي غالبًا ما يرتبط بالتواصل الشفهي باللغة الإنجليزية

## 1.1 Background of the Study

English has become a global language for communication, education, and professional advancement· However, effective communication is not merely dependent on vocabulary and grammar but also on phonological accuracy and intelligibility· In the Iraqi EFL context, learners face persistent challenges in English pronunciation due to limited exposure to native speakers, a lack of phonology-focused instruction, and interference from Arabic phonological patterns· Common difficulties include the substitution of /p/ with /b/, mispronunciation of /θ/ and /ð/, devoicing of final consonants, and improper stress placement in polysyllabic words· These errors often hinder learners' oral proficiency and reduce their confidence in using English in academic and professional settings· With recent advances in Artificial Intelligence (AI), educational technology has provided innovative solutions to language learning challenges· AI-powered applications such as Google Speech Recognition, ELSA Speak, and YouGlish allow learners to receive real-time feedback, compare their pronunciation with authentic models, and engage in repetitive practice without the limitations of classroom time· In contexts like Iraq, where access to qualified phonology instructors is limited, such tools can supplement traditional instruction and improve students' pronunciation and listening comprehension·

## 1.2 Statement of the Problem

Even though the importance of English proficiency is on the rise, a number of Iraqi students still struggle to attain an intelligible pronunciation. The conventional methods of teaching in universities are more focused on grammar and vocabulary and in most cases they pay little attention to teaching phonology. This leads to learners being unable to acquire natural rhythm of speech and proper production of sounds. Such constraints make them poor at academic presentations, cross-border exams, and workplace communication. In addition, the absence of progressive phonology laboratories in the majority of Iraqi universities limits the possibilities of practical training. This research will help fill this gap by exploring how AI tools can be used to develop pronunciation and reduce phonological errors among Iraqi EFL learners.

## 1.3 Objectives of the Study

The primary goal of this research is to investigate how artificial intelligence can be used to improve English phonology among Iraqi EFL learners. Particularly, the study aims to establish the effectiveness of AI-based resources in improving segmental and suprasegmental qualities of pronunciation, research the modification of speech recognition and general intelligibility among Iraqi students, and evaluate how AI-based pronunciation training contributes to confidence and motivation in oral communication among students.

### 1.4 Research Questions:

This paper aims to answer a number of major research questions regarding the application of AI in enhancing pronunciation skills of English among Iraqi students. It will discuss the level at which AI-based solutions can help students to

improve the pronunciation of the problematic phonemes and stress patterns in the English language, the degree to which AI applications can affect speech intelligibility among the students through acoustic analysis and expert judgment, and the influence of AI-based training on self-confidence and motivation of the students in English oral performance.

## 1.5 Significance of the Study

The research is important on various levels. It gives learners a chance to improve their speech intelligibility and tonify pronunciation-related anxiety with the help of the available AI-based tools. As a teacher, it presents a good way of learning how the technology can be successfully integrated in the process of teaching pronunciation. It informs policymakers and curriculum developers in Iraq that there is a necessity to incorporate AI-based tools in English language programs so that it is more adaptable to communication demands in the world.Moreover, the research can be used in fields of applied linguistics, as it provides empirical data regarding the purpose of AI in phonology training in a relatively understudied Middle Eastern setting.

## 1.6Scope and Limitations:

This research will focus on undergraduate students of the University of Baghdad, Al-Mustansiriyah University and Al-Mansour University College. It explores AI-driven tools in solving phonological challenges in 12 weeks of intervention. Despite the fact that the results should be helpful in terms of the role of AI in the training of pronunciation, the study is limited by multiple factors, such as the use of existing applications, rather short period of intervention, and a small sample size

of 120 people. In this regard, the results may not be very generalized to all learners in Iraq or other EFL environments.

## 2:Theoretical Background and Literature Review

### 2.1 Phonology and its Role in English Language Learning

Phonology, the systematic organization of sounds in a language, is a foundational aspect of successful communication, as it governs both the recognition and production of speech· Accurate phonological competence enables learners not only to articulate words correctly but also to convey meaning clearly and be understood by native and non-native speakers alike· In second language acquisition, the ability to produce intelligible speech often outweighs the need for native-like pronunciation, yet phonological challenges remain a major source of difficulty for learners· For Arabic-speaking students learning English, these challenges are particularly pronounced due to the substantial structural differences between the two languages' sound systems· Arabic lacks several English phonemes, most notably /p/ and /v/, which frequently results in substitution errors; Iraqi learners typically produce /p/ as /b/ and /v/ as /f/, as in pronouncing park as bark or very as fery· Similarly, the interdental fricatives /θ/ and /ð/, absent in Arabic, are often replaced with dental or alveolar stops /t/ and /d/, resulting in think becoming tink and this becoming dis (Al-Ani, 1970; Kharma & Hajjaj, 1989)· Beyond individual phonemes, Iraqi learners also face difficulties with suprasegmental features of English, including stress, rhythm, and intonation. Arabic is largely a syllable-timed language, where each syllable is pronounced with roughly equal duration, whereas English is stress-timed, with stressed syllables occurring at relatively regular intervals and unstressed syllables shortened or reduced· This fundamental difference often leads to irregular speech patterns in Iraqi students' English, such

as misplaced word stress, monotone intonation, or inappropriate pauses within connected speech· Final consonant devoicing, vowel length misperception, and cluster simplification further exacerbate intelligibility issues· Even students with strong grammatical and lexical knowledge frequently struggle to communicate effectively due to these phonological gaps, which can lead to frustration, reduced speaking confidence, and social or academic anxiety (Derwing & Munro, 2015)·

Despite the clear impact of phonological competence on communication, pronunciation instruction in Iraqi universities is typically minimal or inconsistent· Curricula often prioritize grammar, reading, and writing over systematic pronunciation training, leaving students without structured opportunities to address persistent phonetic challenges· Traditional classroom methods, such as repetition drills or imitation, are frequently insufficient to overcome deeply ingrained first-language influence· Recent research emphasizes that intelligibility should be the primary goal of pronunciation teaching, rather than an unattainable pursuit of native-like speech (Derwing & Munro, 2015; Saito, 2011)· Moreover, modern technological tools, including speech recognition software and AI-assisted pronunciation applications, have shown promise in providing immediate feedback, individualized practice, and increased learner engagement· Such innovations can help learners identify specific error patterns, practice phonemes in varied contexts, and develop greater awareness of prosodic features, offering a more efficient and motivating alternative to traditional instruction methods·

Given these challenges and the growing availability of AI-based tools, there is a critical need to investigate how technology can support Iraqi students in acquiring more intelligible English pronunciation· Understanding the interaction between phonological difficulties, learner strategies, and technological interventions can inform more effective teaching practices, curriculum design, and ultimately

improve communication outcomes· This research thus aims to explore the impact of AI-assisted tools on the phonological development of Iraqi EFL learners, with particular attention to both segmental (individual sounds) and suprasegmental (stress, rhythm, intonation) features, as well as the role of learners' motivation, confidence, and engagement in facilitating improvement·

## 2.2 Theoretical Models of Second Language Pronunciation Learning

The acquisition of English phonology by Iraqi learners can be better understood through several complementary theoretical models that explain both the challenges and potential strategies for improvement· The Speech Learning Model (SLM), proposed by Flege (1995), asserts that adult second language learners encounter significant difficulty in perceiving and producing sounds that are absent from their native language· According to this model, new phonetic categories in a second language are often assimilated to the closest existing category in the learner's first language, which explains why Iraqi students frequently substitute /p/ with /b/ or /v/ with /f/· Over time, repeated exposure and targeted practice are required to form distinct, accurate categories for these unfamiliar sounds· The Contrastive Analysis Hypothesis (CAH), introduced by Lado (1957), similarly emphasizes that predictable errors arise when learners attempt to map the sound system of their first language onto English· For instance, Iraqi learners' difficulty with English interdental fricatives /θ/ and /ð/ can be anticipated through this approach, as Arabic lacks equivalent sounds, leading to substitutions such as /t/ and /d/· In addition to these phonetic-focused models, broader input-output frameworks provide insight into how learners acquire pronunciation skills· The Input Hypothesis (Krashen, 1985) emphasizes the critical role of exposure to comprehensible input that is slightly beyond the learner's current proficiency level, often referred to as "i+1·"

For Iraqi learners, this implies the need for listening activities, authentic recordings, and exposure to varied English accents in order to internalize target phonemes and prosodic patterns· Conversely, the Output Hypothesis (Swain, 1995) highlights the necessity of meaningful production and interaction, suggesting that learners consolidate their phonological knowledge when they actively produce speech and receive corrective feedback· Output not only reinforces accurate articulation but also helps learners notice gaps between their pronunciation and that of proficient speakers· These theoretical perspectives collectively justify the integration of AI-assisted tools into English pronunciation instruction· Artificial intelligence platforms, such as speech recognition software and AI-driven pronunciation applications, can provide learners with authentic, varied input while simultaneously requiring repeated oral production· Furthermore, these tools can deliver immediate, precise corrective feedback tailored to individual error patterns, effectively bridging the gap between perception and production emphasized in the SLM· By combining continuous exposure, meaningful output opportunities, and instant feedback, AI technologies create optimal conditions for phonological development, particularly in contexts like Iraqi universities where traditional pronunciation instruction is limited or inconsistent· Moreover, AI tools can adapt to learners' proficiency levels, monitor progress over time, and incorporate gamified or interactive elements that enhance engagement and motivation, which are critical for sustained improvement in pronunciation accuracy and overall intelligibility·

## 2.3 Artificial Intelligence and Language Education

Artificial Intelligence has been widely adopted across educational sectors, with significant implications for language learning· AI systems are capable of

simulating human-like responses, adapting to individual learners, and analyzing speech with precision· In language education, AI has been integrated into pronunciation training, grammar correction, automated writing evaluation, and adaptive testing· Applications such as ELSA Speak, Google Speech Recognition, and YouGlish represent AI-driven solutions that enhance learners' exposure to natural speech, provide real-time diagnostic feedback, and allow for repeated practice outside the classroom· Unlike traditional teaching, AI-based learning environments offer flexibility, scalability, and personalization, which are essential in contexts like Iraq where students have limited access to native speaker input and specialized instructors (Li, 2022; Zawacki-Richter et al·, 2019)· Beyond providing immediate feedback, AI technologies support individualized learning paths by continuously monitoring learners' performance and adapting exercises to their specific strengths and weaknesses·

For pronunciation training, AI systems can detect subtle articulatory errors that may go unnoticed in a traditional classroom, such as mispronounced vowels, stress misplacement, or intonation inaccuracies· By generating visual and auditory feedback, learners can compare their own speech with native models, reinforcing correct pronunciation patterns· Additionally, AI facilitates spaced repetition and targeted drills, which are crucial for overcoming fossilized errors that often persist in adult learners· Research indicates that AI-assisted pronunciation tools not only improve segmental accuracy, such as consonant and vowel production, but also enhance suprasegmental features, including rhythm, stress, and intonation, which are critical for overall intelligibility (Tian & Zhou, 2021; Derwing & Munro, 2015)· In the Iraqi educational context, the integration of AI in language learning carries particular significance· Universities often face challenges such as large class sizes, limited access to experienced language instructors, and scarce exposure

to authentic English speech· AI tools help bridge these gaps by offering students opportunities for self-paced, immersive practice that complements classroom instruction· Platforms like ELSA Speak and YouGlish provide learners with authentic, context-rich examples of pronunciation in various accents and speaking styles, enhancing both comprehension and production· Furthermore, AI encourages learner autonomy, motivation, and engagement by enabling repeated practice in a low-pressure environment, which is particularly beneficial for students who may experience anxiety in oral communication· By leveraging AI technologies, Iraqi learners can develop greater confidence, improve intelligibility, and achieve more effective communication outcomes, aligning with contemporary pedagogical goals and preparing them for academic, professional, and intercultural interactions (Li, 2022; Zawacki-Richter et al·, 2019)·

## 2.4 AI and Pronunciation Training:

Pronunciation learning requires accurate models, repeated exposure, and constructive feedback, all of which are made possible through AI· Studies in Asia and Europe have shown that learners using AI-based pronunciation applications demonstrate significant improvements in both segmental and suprasegmental features· Le and Wang (2020) reported that Vietnamese learners improved their accuracy in consonant clusters after using ELSA Speak for 10 weeks, while Tursina (2021) found that Indonesian students increased intelligibility when using Google Speech Recognition· Kartal (2019) demonstrated the value of YouGlish in exposing learners to real-life pronunciation across different English accents, an aspect particularly important for preparing students to engage in global communication· Importantly, these tools not only enhance phonological competence but also reduce learner anxiety and build confidence in speaking (Derakhshan & Alrabai, 2025)· Building on these findings, AI-assisted pronunciation tools offer a promising solution for Iraqi EFL learners who face similar challenges in achieving intelligible and confident spoken English· By providing continuous, personalized feedback, these applications allow learners to identify persistent errors, practice them in varied contexts, and track their progress over time· Unlike traditional classroom settings, where individualized

attention is often limited, AI enables repeated, self-paced practice that accommodates diverse learning speeds and styles· Moreover, exposure to multiple accents and authentic speech through platforms like YouGlish helps students develop more flexible listening skills, which are essential for understanding and participating in real-world communication· Ultimately, integrating AI into pronunciation instruction not only addresses segmental and suprasegmental difficulties but also fosters learner autonomy, motivation, and long-term improvement, making it a valuable pedagogical tool in contexts where access to native speakers and specialized instruction is limited·

## 2.5 The Iraqi Context: Challenges in Pronunciation Instruction

In Iraq, the teaching of English at the tertiary level often neglects systematic pronunciation instruction due to several constraints· First, curricula prioritize grammar and reading comprehension over oral skills· Second, there is a shortage of trained phonology specialists who can provide targeted feedback· Third, many universities lack the technological infrastructure needed for advanced phonetics labs· As a result, students graduate with limited oral competence, which affects their participation in academic discussions, job interviews, and international exchanges· Ali and Salih (2022) note that Iraqi students often mispronounce /p/ and /v/, while Yaseen and Shakir (2021) confirm that stress placement in polysyllabic words remains a consistent problem· CALL-based studies in Iraq (Ahmed, 2019; Jameel, 2020) have addressed vocabulary and grammar but rarely phonology, creating a critical gap that AI can address· These challenges highlight the urgent need for integrating technology-driven solutions, particularly AI, into pronunciation instruction in Iraqi universities· AI-based tools can compensate for the shortage of trained instructors by providing automated, precise, and individualized feedback on pronunciation errors· They also allow learners to practice repeatedly at their own pace, which is essential for mastering difficult phonemes and prosodic features that are often neglected in traditional classrooms·

Moreover, AI platforms can simulate real-life communicative contexts, exposing students to varied accents, speech rates, and situational dialogues, thereby enhancing both comprehensibility and listening skills· By bridging the gap between limited classroom resources and the demands of global English communication, AI has the potential to significantly improve Iraqi learners' oral competence· In addition, the adoption of AI in pronunciation teaching can foster learner autonomy and motivation, which are often hindered by large class sizes and teacher-centered instruction· Students gain the confidence to self-monitor, correct errors, and engage in repeated practice without fear of embarrassment, reducing speaking anxiety and promoting active participation· Importantly, AI-supported learning aligns with contemporary pedagogical approaches that emphasize personalized, feedback-rich environments, making pronunciation practice more effective and engaging· Given the growing importance of English in academic, professional, and international contexts, integrating AI tools into Iraqi tertiary education can address persistent phonological challenges, enhance students' intelligibility, and ultimately equip them with the communicative competence required for success in a globalized world·

## 2.6 Global and Regional Studies on AI in Pronunciation

Globally, research on AI in pronunciation has highlighted its potential to democratize access to oral language training· In China, Wang (2019) found that speech recognition technology significantly improved learners' stress and intonation· In Korea, Wang and Lee (2021) showed that mobile-assisted AI learning increased motivation and reduced avoidance of speaking tasks· In Saudi Arabia, Hago and Khan (2015) highlighted persistent difficulties in phoneme production but did not investigate technological interventions, leaving space for

AI-focused research in the region· The scarcity of Middle Eastern studies on AI in phonology underscores the originality and necessity of investigating its role in the Iraqi context· Given this global context, exploring AI-assisted pronunciation in Iraq offers an opportunity to address both pedagogical gaps and regional research shortages· By examining how Iraqi learners respond to AI tools, researchers can identify effective strategies for improving segmental and suprasegmental features while also assessing learners' motivation, confidence, and engagement· Such investigation not only contributes to the limited body of Middle Eastern research on AI in phonology but also provides practical insights for curriculum design, teacher training, and technology integration in Iraqi universities· Ultimately, this research can serve as a model for similar contexts in the region, demonstrating how AI can enhance oral competence, bridge resource limitations, and prepare students for participation in global academic and professional environments·

## 2.7 Pedagogical Implications of AI in Phonology

AI does not replace teachers but supplements classroom instruction by providing learners with extensive practice opportunities· Teachers can integrate AI applications into assignments, oral presentations, and self-study modules, thereby creating blended learning environments· Furthermore, AI tools promote learner autonomy, allowing students to monitor their progress, repeat practice until mastery, and receive immediate corrections without fear of judgment· This aligns with learner-centered approaches in modern pedagogy and supports the development of communicative competence, which is crucial for academic and professional success· In addition, the integration of AI into language classrooms allows teachers to focus on higher-order instructional tasks, such as facilitating discussion, providing strategic guidance, and addressing individual learner difficulties that require human judgment· While AI handles repetitive drills, error

detection, and personalized feedback, educators can dedicate more time to fostering critical thinking, cultural competence, and interactive communication skills· This synergy between human instruction and AI technology enhances the overall quality of language education by combining the efficiency and precision of AI with the pedagogical expertise and interpersonal support that teachers provide· Moreover, AI-supported learning environments encourage collaborative and peer-assisted activities, where students can compare performance, share progress, and engage in guided peer feedback· Such collaborative practices complement the individualized nature of AI, creating a more holistic approach to pronunciation development· By blending technology-driven practice with teacher guidance and peer interaction, learners experience multiple avenues for reinforcement, motivation, and confidence-building· This comprehensive approach not only improves segmental and suprasegmental accuracy but also prepares students to use English effectively in real-world academic, professional, and intercultural contexts, addressing both skill development and learner empowerment simultaneously·

## 3: Methodology

## 3.1 Research Design

The research design was quasi experimental one with two groups,, experimental (that had AI-assisted pronunciation training) and control (that received traditional classroom training).The selection of this approach is due to the possibility of researching the effectiveness of the intervention in a natural educational environment in which random assignment is not always feasible. The main aim was to study the variations in pronunciation accuracy, speech intelligibility, and phonological recognition of the two groups after a twelve-week intervention. The design also included pre-test and post-test, which enabled the performance of the

learners to be compared prior to and following the treatment. The data collection consisted of quantitative and qualitative aspects: quantitative data were obtained as a result of the acoustic analysis and intelligibility rating, and qualitative information was obtained in the form of observations of the motivation and confidence of learners during the study.

### 3.2 Population and Sample

The study population was undergraduate students studying EFL programs in various universities in Iraq where English is one of the requirements of all language majors. The sample of participants of the target was represented by three higher education institutions, namely University of Baghdad, Al-Mustansiriyah University, and Al-Mansour University college. Through comparison of randomly selected public and privately-run institutions, a representative sample of both of these forms of higher learning was obtained such that the differences in academic setting, mode of instruction and the student population profile can be captured. These are also universities where it is possible to have significant aspects of diversification of student demographics including socioeconomic status, region of origin and previous exposure to the English language; in addition, they are implementing digital tools and technological resource in teaching of the English language that is pertinent to the study on the digital-assisted learning techniques.. A total of 120 students participated in the study, with 60 assigned to the experimental group and 60 to the control group· The participants included both male and female students, all between the ages of 18 and 23, enrolled in undergraduate English language programs· This age range was chosen to maintain consistency in cognitive and linguistic development among participants· To ensure homogeneity in language proficiency, all students were assessed using the Oxford Quick Placement Test (QPT), and only those at the B1–B2 levels of the Common

European Framework of Reference for Languages (CEFR) were included in the sample· This criterion was applied to minimize variability in baseline English proficiency, thereby allowing the study to more accurately examine the effects of the experimental interventions· The careful selection of participants across multiple institutions and the controlled proficiency levels contributed to the overall reliability and validity of the study's findings, ensuring that observed outcomes could be attributed to the instructional interventions rather than extraneous factors·

**Table 1: Demographic Characteristics of Participants**

| Variable | Experimental Group (n=60) | Control Group (n=60) | Total (N=120) |
|---|---|---|---|
| Gender (Male) | 28 | 30 | 58 |
| Gender (Female) | 32 | 30 | 62 |
| Age Range (18–20) | 34 | 33 | 67 |
| Age Range (21–23) | 26 | 27 | 53 |
| Proficiency (B1) | 31 | 29 | 60 |
| Proficiency (B2) | 29 | 31 | 60 |

### 3.3 Instruments and Materials

The instruments and materials employed in this study combined both digital and traditional approaches to provide a comprehensive assessment of students' pronunciation development· The experimental group utilized AI-powered applications, including ELSA Speak, Google Speech Recognition, and YouGlish·

These tools offered learners exposure to authentic pronunciation models, immediate feedback via speech recognition, and contextualized examples of pronunciation in natural discourse, thereby enhancing both accuracy and fluency· To evaluate learners' progress, pre- and post-test assessments were conducted· These assessments required students to read aloud word lists, sentences, and short passages that contained challenging sounds, such as /p/, /v/, /θ/, and /ð/, as well as complex stress patterns in polysyllabic words· The design of these assessments allowed for a detailed analysis of specific phonological difficulties common among Iraqi EFL learners· Acoustic analysis software, specifically Praat, was employed to provide precise measurements of vowel and consonant production, voice onset time (VOT), and prosodic features, including stress and intonation· This quantitative approach complemented the qualitative evaluations, ensuring a more accurate depiction of phonetic improvements· Additionally, an expert phonological evaluation was conducted by a panel of three Iraqi phonology instructors· Each instructor independently rated students' recordings for intelligibility and accuracy· To ensure consistency and reliability, the panel underwent training and calibration sessions, resulting in high inter-rater reliability· Finally, questionnaires were administered to assess learners' attitudes, motivation, and self-confidence· Adapted from Clément (1980) and Deci & Ryan (1985), these structured questionnaires were given both at the start and conclusion of the study, providing insights into the emotional and motivational factors that might mediate the effectiveness of AI-assisted pronunciation training·

3.4**Procedures:** The study was conducted over a period of twelve weeks and was organized into three distinct phases to systematically examine the impact of AI-assisted pronunciation practice·The first phase, the Pre-Testing Phase (Week 1), involved administering a diagnostic pronunciation test to all participants· In addition to producing acoustic recordings for later analysis, students completed a self-report questionnaire designed to measure motivation and self-

confidence, establishing baseline data for both phonological performance and emotional factors· During the Intervention Phase (Weeks 2–11), participants were divided into two groups with different learning approaches· The experimental group engaged in pronunciation practice using AI-powered tools for three 45-minute sessions each week under the researcher's guidance· They utilized ELSA Speak to focus on segmental accuracy, Google Speech Recognition for immediate correction of errors, and YouGlish to gain exposure to authentic pronunciation in natural speech contexts· Meanwhile, the control group continued with traditional instruction, which included teacher-led drills, textbook-based pronunciation exercises, and peer repetition activities, without any AI assistance· The final phase, the Post-Testing Phase (Week 12), required both groups to complete the same assessments administered during the pre-test· This allowed for a direct comparison of performance before and after the intervention, enabling the study to evaluate the effectiveness of AI-supported pronunciation practice relative to conventional teaching methods·

### 3.5 Data Collection and Analysis

Data collection in this study employed a combination of quantitative and qualitative techniques to provide a comprehensive understanding of both performance outcomes and learner experiences· For the quantitative data, pre- and post-test scores were statistically analyzed using paired-sample t-tests and ANCOVA to determine within-group improvements and between-group differences· Additionally, acoustic measurements obtained from Praat were examined to evaluate changes in vowel length, consonant clarity, and stress patterns· To further understand the factors influencing pronunciation development, correlation and regression analyses were conducted to explore the relationship between learners' pronunciation accuracy and their motivational and self-confidence levels· The qualitative data focused on capturing learners' attitudes, motivation, and self-perceptions· Questionnaire responses were analyzed thematically to identify shifts in these emotional and cognitive dimensions over the course of the study· Complementing this, observational notes taken during training

sessions offered insights into student engagement, interaction with AI tools, and behavioral patterns that might explain differences in learning outcomes· Together, these quantitative and qualitative approaches allowed for a holistic assessment of both the effectiveness of AI-assisted pronunciation practice and the learner experience·

### 3.5.1 Pre-Test Findings

Pre-test data were collected to establish baseline proficiency in pronunciation and speech intelligibility for both groups·

**Table (2) Pre-Test Mean Scores of Experimental and Control Groups**

| Feature | Experimental Group (Mean ± SD) | Control Group (Mean ± SD) |
|---|---|---|
| Consonant Accuracy (%) | 61.2 ± 8.4 | 60.7 ± 7.9 |
| Vowel Accuracy (%) | 64.5 ± 7.2 | 65.0 ± 6.8 |
| Stress Accuracy (%) | 55.3 ± 6.5 | 54.9 ± 6.1 |
| Intonation Accuracy (%) | 57.8 ± 7.0 | 58.2 ± 6.6 |
| Overall Intelligibility (%) | 59.7 ± 6.9 | 59.5 ± 7.1 |
| Motivation & Confidence (1–5) | 3.2 ± 0.6 | 3.1 ± 0.5 |

Analysis of pre-test scores indicated no significant differences between groups, confirming baseline equivalence· This ensured that any observed post-test differences could be attributed to the AI intervention·

### 3.5.2 Post-Test Findings

After the 12-week intervention, both groups were assessed using the same tasks.

**Table 3: Post-Test Mean Scores of Experimental and Control Groups**

| Feature | Experimental Group (Mean ± SD) | Control Group (Mean ± SD) | t-value | p-value |
|---|---|---|---|---|
| Consonant Accuracy (%) | 81.5 ± 6.2 | 65.3 ± 7.1 | 12.43 | <0.001 |
| Vowel Accuracy (%) | 83.2 ± 5.8 | 66.1 ± 6.7 | 13.21 | <0.001 |
| Stress Accuracy (%) | 77.4 ± 6.0 | 57.5 ± 6.2 | 15.12 | <0.001 |
| Intonation Accuracy (%) | 79.1 ± 5.9 | 58.8 ± 6.0 | 14.37 | <0.001 |
| Overall Intelligibility (%) | 80.3 ± 5.7 | 60.2 ± 6.5 | 16.05 | <0.001 |
| Motivation & Confidence (1–5) | 4.3 ± 0.5 | 3.3 ± 0.5 | 11.84 | <0.001 |

This result suggests that all characteristics were better scored in the experimental than in the controls with the outstanding significances appearing in consonant accuracy, vowel accuracy, stress placement, intonation and overall intelligibility. The same applied to motivation and confidence which also improved easily in the experimental group.

### 3.5.3 Segmental Features Analysis

Consonants: Acoustic analysis showed a significant improvement in the production of problem consonants like /p/, /v/ /th and /dh/ ·

**Table 4 Improvement in Consonant Accuracy (%)**

| Consonant | Pre-Test | Post-Test | Improvement (%) |
|---|---|---|---|
| /p/ | 58.3 | 83.1 | +24.8 |
| /v/ | 60.7 | 82.5 | +21.8 |
| /θ/ | 55.2 | 79.4 | +24.2 |
| /ð/ | 56.2 | 80.1 | +23.9 |

These consonants improved little (35%) in the control group, proving the efficacy of AI feedback in the experimental group.

Vowels: In the experimental group, the differences between long and short vowels became significantly better, judged by Praat. Differences in formant frequencies approached native-like patterns.

**Table 5 Vowel Accuracy Improvement (%)**

| Vowel Type | Pre-Test | Post-Test | Improvement (%) |
|---|---|---|---|
| /i:/ | 62.1 | 84.5 | +22.4 |
| /ɪ/ | 63.5 | 82.3 | +18.8 |
| /u:/ | 65.0 | 83.0 | +18.0 |
| /ʊ/ | 64.3 | 82.7 | +18.4 |

### 3.6 Suprasegmental Features Analysis

Patterns of Stress: AI training enabled learners to train on polysyllabic words with the correct primary stress placement increased to 774% after the intervention but remained at 575% in the control group.

Intonation: Sentence-level intonation patterns Sentence-Level intonation patterns on correct rising and falling patterns improved, 57.8-79.1% of the cases.

Overall Intelligibility: Summing up segmental and suprasegmental improvements, the experimental group had 80% and 3% overall intelligibility than the control group wherein the overall intelligibility was 60%.

### 3.6.1 Motivation and Confidence

The self-report questionnaires of learners showed that AI training has a positive impact on motivation and self-confidence 0 Students expressed that they were more willing to speak English, they felt less anxious, and more engaged during practice times.

**Table 6: Motivation and Confidence Scores**

| Measure | Pre-Test | Post-Test | Change |
|---|---|---|---|
| Motivation (1–5) | 3.2 | 4.3 | +1.1 |
| Confidence (1–5) | 3.1 | 4.2 | +1.1 |

Correlation analysis revealed that there was a positive significant relationship between motivation scores and pronunciation improvement (r = 068, p = 001), and that the more engaged the better the learning outcome.

### 3.7 Regression and Mediation Analysis

The effect of AI on pronunciation improvement was tested with the help of a regression model to determine whether motivation and confidence mediated this effect:

- Direct effect of AI tools on pronunciation: $\beta = 0{\cdot}72$, $p < 0{\cdot}001$

- Indirect effect via motivation and confidence: $\beta = 0{\cdot}25$, $p < 0{\cdot}01$
- Total effect: $\beta = 0{\cdot}97$, $p < 0{\cdot}001$

It shows that AI does not only have a direct positive impact on pronunciation but also on the emotional factors of learners, which in turn lead to the improvement of performance in the phonological domain.

**Discussion**

The findings of this study provide strong evidence that AI-powered tools significantly improve pronunciation, phonological awareness, and speech intelligibility among Iraqi EFL learners· The experimental group, which used applications such as ELSA Speak, Google Speech Recognition, and YouGlish, demonstrated marked improvement in both segmental features, including consonant and vowel accuracy, and suprasegmental features, including stress placement and intonation patterns· These results are consistent with previous studies (Le & Wang, 2020; Tursina, 2021), confirming that AI can provide immediate corrective feedback and repeated exposure, which are essential for mastering non-native phonemes· In contrast, the control group, which relied on traditional classroom drills, showed only minimal improvement, highlighting the limitations of conventional instruction in addressing phonological challenges· The study also emphasizes the role of emotional factors in language learning· Motivation and self-confidence were significantly higher in the experimental group after AI-based intervention, and correlation analysis revealed that these factors positively mediated pronunciation improvement· This aligns with Derakhshan and Alrabai (2025), who argued that learner affective states directly influence language performance· In the Iraqi context, where learners often experience anxiety due to limited exposure to native English pronunciation and the lack of phonology-

specialized instruction, AI tools serve a dual purpose: enhancing phonological skills and providing a supportive, low-pressure environment for practice· Acoustic analysis using Praat and expert ratings further validated the learners' progress, demonstrating objective improvements in pronunciation accuracy· The gains in consonant production, vowel length distinctions, and stress patterns indicate that AI applications can approximate native-like pronunciation more effectively than traditional methods· The integration of authentic audiovisual input through platforms like YouGlish also contributed to the learners' understanding of prosodic features, demonstrating the importance of combining technological intervention with real-world language models· These findings have broader implications for language teaching theory and practice· From a theoretical standpoint, the study confirms the predictions of the Speech Learning Model (Flege, 1995) and Contrastive Analysis Hypothesis (Lado, 1957), suggesting that systematic feedback and repeated exposure are critical for overcoming first language interference· Additionally, the study supports the Input Hypothesis (Krashen, 1985) and Output Hypothesis (Swain, 1995) by showing that AI provides both comprehensible input and opportunities for meaningful output· Pedagogically, the findings demonstrate that AI tools can supplement traditional classroom instruction, fostering learner autonomy, individualized learning, and engagement, which are key elements in modern EFL instruction·

## Conclusion

The results of this research suggest that the Artificial Intelligence is one of the most effective tools that can be used to improve the English phonology of Iraqi EFL students. Students undergoing AI-assisted training had a much higher performance compared to students in regular classes in terms of segmental accuracy, suprasegmental features, overall intelligibility, and communicative

confidence. Besides enhancing pronunciation, AI tools were also discovered to have a positive impact on the motivation and self-confidence of learners, which led to better learning outcomes. Moreover, the study shows that classroom instruction is no longer enough to address the old phonological problem of the Iraqi students particularly in the production of consonants and stress placement. All in all, the results emphasize the pedagogical importance of AI in EFL in higher education and propose that universities need to think about integrating AI-based tools in their regular curricula.

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