BILINGUAL PUBLISHING GROUP

Forum for Linguistic Studies

https://journals.bilpubgroup.com/index.php/fls

ARTICLE

A Systematic Review of Experimental Methods in EFL Pronunciation Enhancement: Trends, Technologies, and Gaps

Renata Kunova [1] ***, Zdena Kralova*** [1,2]

[1] *Department of English Language and Culture, Constantine the Philosopher University in Nitra, Nitra 949 01, Slovakia*

[2] *Department of Modern Languages and Literatures, Tomas Bata University in Zlin, Zlin 760 01, Czechia*

ABSTRACT

As education evolves in tandem with societal and technological advancements, research methodologies must adapt to meet emerging needs. This systematic review explores recent experimental approaches to enhancing the pronunciation of English as a Foreign Language (EFL). Ten peer-reviewed studies published between 2019 and 2024 were analyzed using PRISMA guidelines. All studies employed the quasi-experimental design and were conducted in Asia and Europe, reflecting a regional concentration of research efforts. The interventions varied widely, incorporating innovative tools such as speech visualization technologies, robot tutors, AI-powered applications, and personalized feedback systems. These methods enhanced learners' pronunciation accuracy, fluency, and overall speaking proficiency. The review highlights a prevailing reliance on quasi-experiments due to practical constraints in educational settings, such as challenges with random assignment. While the studies showcased promising short-term outcomes, a notable gap was identified in using longitudinal research models, limiting insights into sustained effects. Additionally, some studies lacked robust statistical analysis or had small sample sizes, which may affect the generalizability of findings. The findings underscore the importance of integrating modern technologies and interactive strategies into pronunciation instruction. They also emphasize the need for more geographically diverse and methodologically rigorous research. Unlike previous reviews, this study focuses on technological interventions and affective outcomes, identifying a lack of longitudinal research in EFL pronunciation experiments. Future studies should prioritize long-term evaluations and broader samples to strengthen the evidence base for effective EFL pronunciation interventions.

*CORRESPONDING AUTHOR:

Zdena Kralova, Department of English Language and Culture, Constantine the Philosopher University in Nitra; Email: zkralova@ukf.sk

ARTICLE INFO

Received: 5 July 2025 | Revised: 17 July 2025 | Accepted: 28 July 2025 | Published Online: 23 September 2025
DOI: https://doi.org/10.30564/fls.v7i10.10900

CITATION

Kunova, R., Kralova, Z., 2025. A Systematic Review of Experimental Methods in EFL Pronunciation Enhancement: Trends, Technologies, and Gaps. Forum for Linguistic Studies. 7(10): 165–178. DOI: https://doi.org/10.30564/fls.v7i10.10900

Keywords: Systematic Review; PRISMA; Experimental Method; EFL Pronunciation; Enhancement

1. Introduction

Pronunciation is often perceived as one of the most challenging yet key areas in foreign language instruction [1]. While good pronunciation can positively influence the language learning process, poor pronunciation can represent significant obstacles [2]. Several authors [3–5] highlight the undeniable complexity of pronunciation improvement, underscoring the importance of ongoing research in foreign language pronunciation instruction. Experimental research holds a unique position in language pedagogy, as it allows for the rigorous testing of cause-and-effect relationships, which is essential when evaluating instructional interventions. Unlike observational or correlational studies, experimental designs offer a higher degree of control and replicability, making them ideal for isolating the effects of specific teaching strategies on pronunciation outcomes [6,7].

Two recent systematic reviews have also contributed to the growing body of literature on experimental approaches to English as a Foreign Language (EFL) pronunciation instruction. Huo and Wang [8] conducted a synthesis of 15 experimental and quasi-experimental studies published between 2000 and 2016, focusing on phonologically-based instruction such as phonemic awareness and phonics at the primary school level. Their findings indicated moderate positive effects on early literacy skills, particularly phonemic awareness and non-word reading, though effects on word recognition and reading comprehension were minor and more variable. In a more recent review, Metruk [9] examined 15 empirical studies from 2015 to 2022 that explored mobile-assisted language learning in pronunciation instruction. Following PRISMA 2020 guidelines, the study highlighted mobile technologies' positive impact on learners' pronunciation performance and attitudes.

While previous reviews offer valuable insights into specific instructional modalities, they have emphasized general pedagogical trends, learner attitudes [10,11], and technological tools without systematically analyzing the methodological rigor or causal inferences that experimental approaches enable. This omission limits the field's ability to draw evidence-based conclusions about what works in EFL pronunciation teaching. The current systematic review addresses this gap by focusing specifically on experimental studies. It directly formulates the research questions concerning the types of experimental designs employed, the nature of intervention strategies, and their pedagogical implications. It aims to provide a broader synthesis of experimental research across diverse technological and pedagogical interventions, learner populations, and educational contexts.

This systematic review aims to provide an overview of current trends and tendencies in experimental research on pronunciation enhancement in EFL learners. It seeks to respond to the following research questions:

- RQ1: What experimental designs are currently being applied to investigate pronunciation enhancement in EFL learning?
- RQ2: What intervention strategies are popular in EFL pronunciation enhancement research?
- RQ3: What are the pedagogical implications of experimental research on pronunciation enhancement in EFL learners?

By synthesizing recent experimental research, this review seeks to inform EFL educators, curriculum developers, and teacher trainers about effective, empirically supported strategies for enhancing pronunciation instruction. The findings may also guide researchers in identifying underexplored areas and developing future intervention studies that are pedagogically sound and contextually adaptable.

2. Literature Review

2.1. Experimental Designs in EFL Pronunciation Research

Experimental research is widely recognized in EFL pronunciation research for its ability to establish cause-and-effect relationships [6,7]. Among the various types of experimental designs, true experimental, quasi-experimental, and single-subject designs are most discussed [12,13]. True experiments involve random assignment and control groups, offering high internal validity. However, in educational contexts, ethical and logistical constraints often make randomized con-

trolled trials impractical[14,15]. As a result, quasi-experiments are more prevalent in EFL pronunciation research. These designs typically lack random assignment but still employ pre-tests and post-tests to assess the effects of instructional interventions[6,7]. Single-subject designs, though less common, are used to observe behavioral changes in individuals over time[16].

In school-based settings, randomly assigning students to experimental and control groups is frequently impractical or ethically questionable, especially when such assignments might affect access to potentially beneficial instructional interventions[14]. Additionally, institutional policies, parental consent requirements, and classroom scheduling complexities further hinder the feasibility of randomized controlled trials. As a result, researchers often rely on quasi-experimental designs, which allow for the study of interventions in naturalistic settings. However, the absence of random assignment in these designs introduces potential threats to internal validity, such as selection bias and confounding variables[15]. Consequently, while quasi-experiments offer valuable insights into real-world educational practices, they limit the strength of causal inferences drawn from the findings[14].

2.2. Intervention Strategies in EFL Pronunciation Enhancement

The previous studies employed a variety of intervention strategies, which can be broadly categorized into traditional and technological approaches. Traditional methods included phonics instruction, chant-based rhythm training, and orthographic rule instruction[17–19]. These approaches focused on segmental and suprasegmental features of pronunciation and were effective in improving rhythm, stress, and intelligibility. Overall, integrating innovative technologies and traditional methods demonstrated positive outcomes in pronunciation accuracy, intonation, fluency, and learner motivation[20,21].

Technological advancements have significantly influenced the landscape of EFL pronunciation research in recent years. A growing number of studies have incorporated digital tools such as speech visualization software (e.g., CE waveform, PP2)[22], PRAAT-based feedback systems[23], robot tutors[24], and Artificial Intelligence (AI)-powered applications like Google Assistant[25]. These innovations have enabled more personalized, multimodal, and interactive learning experiences, often yielding measurable improvements in pronunciation accuracy, intonation, and learner engagement[20,26]. Integrating speech recognition systems and dynamic assessment frameworks has further allowed researchers to explore affective outcomes such as reduced anxiety and increased motivation[19,26].

2.3. Pedagogical Implications of Experimental Research

The findings of most studies underscore the importance of modernizing pronunciation pedagogy through the integration of technology and interactive learning methods. Personalized feedback, multimodal instruction, and learner-centered approaches were found to enhance pronunciation outcomes and reduce language anxiety[23,26]. Pedagogical implications include the need for teacher training programs to incorporate pronunciation-specific strategies and the adoption of evidence-based interventions in curricula[27]. Additionally, the studies highlight the value of affective outcomes such as increased learner motivation and enjoyment[19,25]. These findings align with Derwing and Munro's[28] call for multimodal and affectively supportive pronunciation instruction.

3. Methods

This section outlines the methodological framework employed in conducting the present systematic review. Adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[29], the review was designed to ensure transparency, rigor, and replicability in identifying, selecting, and analyzing relevant literature. The aim was to synthesize recent experimental research on enhancing EFL pronunciation, using clearly defined inclusion and exclusion criteria and a structured search strategy across reputable academic databases.

While both meta-analyses and narrative reviews offer valuable insights, a systematic review was chosen for this study due to the heterogeneity of the included studies in terms of intervention types, participant populations, and outcome measures. A meta-analysis requires a high degree of statistical compatibility across studies, which was not feasible given the diverse methodologies and reporting standards observed. Similarly, a narrative review, while flexible, lacks the methodological transparency and replicability required

to rigorously assess trends in experimental research [30]. By adhering to PRISMA guidelines, this systematic review ensures a structured, replicable, and comprehensive synthesis of recent experimental studies on EFL pronunciation enhancement. This approach allows for identifying patterns, gaps, and emerging technologies in the field while maintaining methodological rigor.

3.1. Eligibility Criteria

Specific criteria were applied to determine eligibility for inclusion in this systematic review. Articles were included if they were published within the last five years (2019–2024), written in English, published in peer-reviewed journals, available in open-access format, and centered around experimental research in the context of EFL pronunciation enhancement. Articles were also excluded if they did not explicitly address experimental research methods or their application to EFL pronunciation. Duplicate studies were also removed during the evaluation of eligibility criteria.

Articles were also excluded if classified as grey literature or non-peer-reviewed sources. While grey literature (e.g., conference papers, theses, and technical reports) can offer valuable insights, particularly into emerging or innovative practices, it was excluded from this review to ensure a consistent standard of methodological rigor and peer-reviewed quality. However, this exclusion may introduce a publication bias, as unpublished or non-peer-reviewed studies with null or negative results are less likely to be represented. Consequently, some innovative interventions or early-stage findings may have been overlooked, potentially limiting the scope of the review. Future reviews might thus consider including grey literature to capture a broader spectrum of experimental approaches in EFL pronunciation research.

3.2. Information Sources and Search Strategy

The literature search was conducted in December 2024 across two databases (Web of Science and Scopus) and one register, the Education Resources Information Center (ERIC). These sources were selected based on their complementary strengths and relevance to the research focus. The Web of Science (WoS) and Scopus were chosen for their broad coverage of high-impact, peer-reviewed journals across disciplines, ensuring access to rigorous and widely cited studies. ERIC was included due to its specialized focus on educational research, particularly in language pedagogy and instructional methods. This combination allowed for a comprehensive yet targeted retrieval of studies relevant to experimental research in EFL pronunciation instruction.

To identify the most relevant documents, the collocation phrase "*experiment AND pronunciation AND EFL*" was used. This combination of keywords guaranteed a focused search on studies investigating experimental research methods in enhancing pronunciation among EFL learners. Boolean operator "AND" was applied consistently across all databases and registers to refine the search results and maintain uniformity in the search process. The initial search yielded a total of 54 articles, distributed across the databases Web of Science (19 articles), Scopus (27 articles), and the register ERIC (8 articles). After removing 13 duplicate articles and 5 articles marked as ineligible by automation tools, 36 studies remained for screening and further evaluation.

3.3. Screening and Selection Process

As shown in **Figure 1**, there were initially 36 articles in the screening process. To ensure that only the most eligible studies are included, the screening process was divided into a two-stage procedure. The first stage focused on title and abstract screening, meaning that records were excluded if their titles and abstracts did not meet the inclusion criteria. At this stage, 15 articles were excluded primarily for lacking experimental designs or focusing on non-EFL populations. This preliminary filtering allowed for the rapid identification of studies that were irrelevant or outside the scope of the review.

After passing the initial stage, the remaining 15 articles underwent an extensive full-text review to ensure that they still met the eligibility criteria. This second stage involved a more in-depth evaluation of each study's methodology, sample characteristics, and relevance to the research questions. During this stage, 5 articles were excluded, as they did not meet the inclusion criteria. Reasons for exclusion at this stage included insufficient methodological detail, lack of focus on the target population, or absence of outcomes relevant to the systematic review. The 10 studies that remained are included in this systematic review. These final studies represent the core evidence base for the review and provide the foundation for subsequent analysis and discussion.

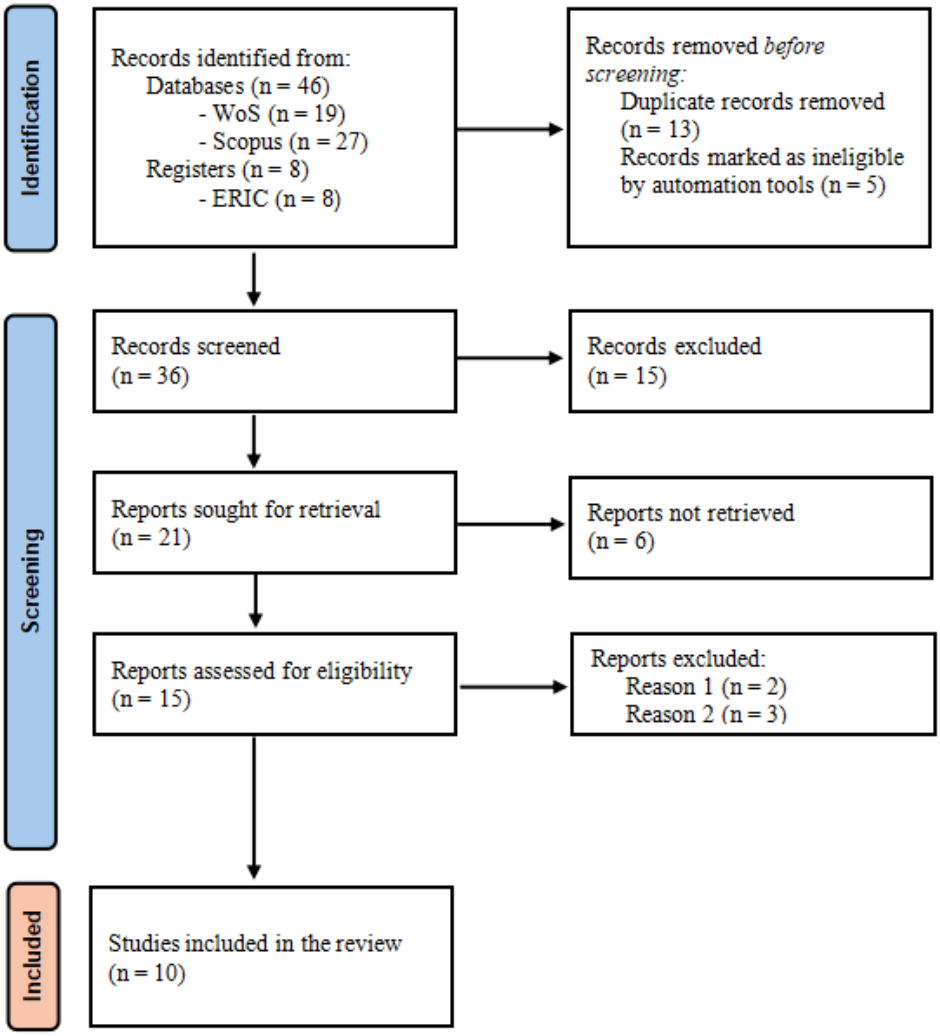

Figure 1. Adapted PRISMA Flow Diagram [29].

4. Results

Table 1 provides an overview of the 10 studies selected for inclusion in this systematic review, outlining key information such as author(s), title, year of publication, and country of origin. To maintain a global perspective, the selection process prioritized geographical diversity.

As illustrated in **Figure 2**, the studies span several continents, reflecting a wide range of sociolinguistic and educational contexts. Among these, Asia emerged as the most represented continent, contributing nine of the ten studies, indicating a strong research interest in the topic within this region. The remaining study originated from a European country, highlighting a notable imbalance in regional representation. This disparity may point to differences in research priorities, funding availability, or academic traditions across regions, which suggests potential gaps in the existing literature and underscores the need for more geographically inclusive research in the future.

The overwhelming dominance of Asian studies highlights a significant regional bias that warrants critical examination. While this concentration may reflect Asia's strong policy emphasis on EFL, robust educational funding, and a growing interest in integrating technology into language instruction [31], it also raises concerns about the global applicability of the findings. Countries such as China, Taiwan, Japan, and Indonesia have made substantial investments in EFL education, often supported by national curricula and government-backed initiatives prioritizing English proficiency as a key economic and academic goal [32]. These conditions create fertile ground for experimental research and technological innovation in pronunciation instruction.

Table 1. The Final Set of Included Studies.

Study	Title, Author(s), Year
1	Improving Accuracy in Imitating and Reading Aloud via Speech Visualization Technology [22]
2	Learning English Intonation Through Exposure to Resynthesized Self-Produced Stimuli [23]
3	Utilizing Robot-Tutoring Approach in Oral Reading to Improve Taiwanese EFL Students' English Pronunciation [24]
4	Developing Phonics Material to Improve the Spoken English of Indonesian Tertiary Students [17]
5	AI-Powered Applications for Improving EFL Students' Speaking Proficiency in Higher Education [25]
6	Effect of Phonological and Phonetic Interventions on Proficiency in English Pronunciation and Oral Reading [21]
7	Teaching Stress-Timed Rhythm of English at the Japanese Elementary School Level: Focusing on the Effects of Using Chants [18]
8	The Use of YouTube in Developing the Speaking Skills of Jordanian EFL University Students [20]
9	Explicit Instruction of Pronunciation Learning Strategies and Word-Stress Rules: Examining Learners' Reflections from Diary Entries [19]
10	Influences of Integrating Dynamic Assessment into a Speech Recognition Learning Design to Support Students' English Speaking Skills, Learning Anxiety and Cognitive Load [26]

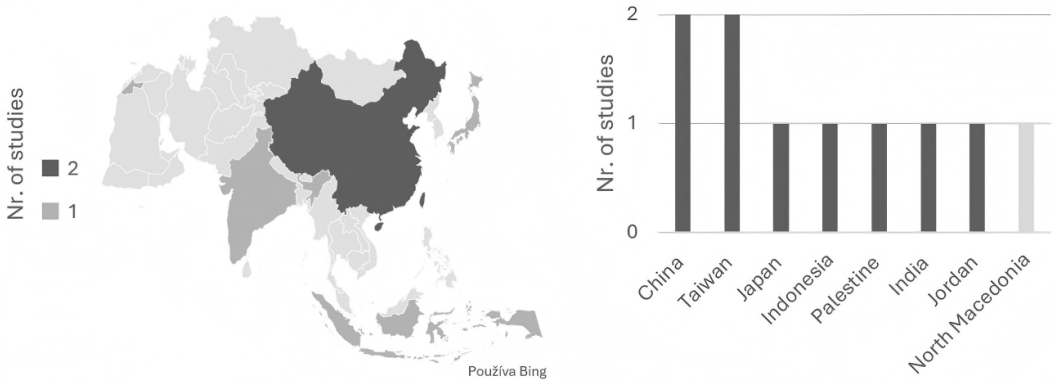

Figure 2. Country Representation in the Selected Studies.

However, this regional dominance limits the generalizability of the results to other sociocultural and pedagogical contexts. For instance, cultural attitudes toward pronunciation accuracy, classroom dynamics, and learner motivation may differ significantly in Western, African, or Latin American settings [32]. Moreover, the pedagogical frameworks and technological infrastructure available in Asian institutions may not be readily replicable elsewhere. This imbalance underscores the need for more geographically diverse research to ensure that instructional strategies are adaptable across varied educational landscapes. Future studies should include underrepresented regions to build a more inclusive and globally relevant evidence base for EFL pronunciation instruction.

Study 1 investigated how speech visualization technology improves pronunciation and intonation in activities focusing on imitation and reading aloud (IRA). The study utilized a clear quasi-experimental pre-test/post-test design, which lasted 3 months. The research sample consisted of 80 Chinese high-school students, with an equal number of respondents in the experimental and control groups. The experimental group was exposed to speech visualization tools, such as CE waveform and PP2, both in laboratory and home settings. In contrast, the control group was exposed to conventional instructor-guided methods. Post-intervention tests revealed that the experimental group demonstrated a higher level of performance in comparison to the control group in terms of both pronunciation accuracy and total IRA scores [22].

Study 2 aimed to investigate the effect of resynthesized self-produced stimuli on improving intonation in English. A quasi-experimental pre-test/post-test design was utilized, lasting 12 weeks, with an equal sample size in both the experimental and control groups. The experimental group consisted of 33 first-year university English majors with Chinese L1. During the experiment, the focus group worked with personalized intonation feedback created using the PRAAT software, while the control group followed native-speaker patterns. The post-test results revealed substantial enhancement of the quality of phonetic realization and intonation of the experimental group (EG), surpassing the performance of the control group (CG). The study confirmed the effective-

ness of personalized stimuli with a focus on common tonal interference with L1 [23].

Study 3 was focused on investigating a robot-tutoring system to improve pronunciation in reading-aloud tasks. The experimental design included a single-group pre-test/post-test with a delayed post-test, and 19 Taiwanese university students formed the research sample. There was no control group. During the research, respondents engaged in self-training using a system designed to diagnose and correct pronunciation errors. The results of the delayed post-test revealed a significant improvement in pronunciation accuracy (48.42% vs. 58.00%, $p < 0.05\%$). The results highlight the importance of innovative methods in learning English pronunciation [24].

Study 4 investigated the effectiveness of Phonics-based materials designed to improve pronunciation. The experimental design was a one-group pre-test/post-test design, with the research sample consisting of eight Indonesian university students. The intervention, lasting seven weeks, focused on problematic phenomena. The intervention consisted of Phonics instructions and pre-recorded reading tasks. Surveys conducted after the intervention revealed significant improvement, namely in "silent letters" [17].

In Study 5, the researchers focused on the impact of the Google Assistant Conversation App on speech proficiency. The study employed a one-group pre-test/post-test design. Qualitative focus-group discussions were conducted post-intervention. The experimental group comprised 66 Palestinian university students, while the control group was absent. Respondents recorded and sent dialogues on topics related to a specific course. Post-intervention testing showed improvements in pronunciation, fluency, grammar, and vocabulary. Post-intervention focus groups then highlighted students' satisfaction with the app [25].

In Study 6, the researchers evaluated the effects of a targeted phonetic and phonological intervention on pronunciation. The one-group pre-test/post-test experimental design was targeted at 32 prospective English language teachers from India. The experiment focused on a targeted 20-hour training session for the experimental group, focusing on clarity, pitch variation, and the use of gestures. There was no control group in the study. Post-intervention testing revealed improvements in pronunciation, overall fluency, and other areas of oral expression [21].

Study 7 examined the use of chant-based instruction to improve stress-timed rhythm performance and overall speech intelligibility. The study involved a pre-test/post-test controlled field experiment with 91 Japanese elementary students. Over a one-semester period, respondents received training focused on both segmental and suprasegmental features of the English language. The results demonstrated significant improvement on both language levels, leading to recommendations for implementing non-conventional approaches to pronunciation instruction [18].

Study 8 investigated the effects of using YouTube to enhance EFL students' speaking skills, emphasizing pronunciation, fluency, coherence, grammar, and lexical resources. The study employed a quasi-experimental pre-test/post-test design, while the intervention lasted 16 weeks. The sample included 80 Jordanian EFL university students, equally divided into the experimental and control groups. The experimental group worked with structured YouTube assignments, while the control group used a traditional textbook approach focusing on drills. Results revealed significant improvements in the experimental group, especially in pronunciation (mean difference = 0.72) and fluency and coherence (0.6), confirmed by a statistical analysis. The results of this study demonstrated the potential of YouTube as an innovative tool for pronunciation teaching in EFL contexts [20].

Study 9 focused on improving word stress placement in Macedonian EFL learners by using orthographic rules and specific pronunciation learning strategies. The study employed a pre-test/post-test design combined with qualitative thematic analysis, while the sample comprised 40 first-year undergraduate students. Out of the research sample, only 20 students were in the experimental group, yet there is no mention of the control group in the study. During the 4-week intervention period, which was based on Dickerson's 3Ps model, promising findings occurred. Key findings included overall improvement of pronunciation as well as students' satisfaction with the learning approach [19].

In comparative Study 10, the researchers focused on dynamic assessment-based speech recognition (DA-SR) and corrective feedback-based speech recognition (CF-SR). In a pre-test/post-test non-randomized design, they focused on the impacts of the mentioned approaches on speaking skills, anxiety, and cognitive load of Taiwanese elementary school students. The findings indicated that the DA-SR approach

was particularly efficacious in improving pronunciation, as it was also effective in reducing overall cognitive effort and anxiety[26].

As illustrated in **Figure 3**, the most prevalent experimental design is the quasi-experimental pre-test/post-test design in 5 studies (Studies 1, 2, 8, 9, 10). This finding also confirms the claim of several researchers about the difficulties of implementing randomized experiments in educational research and the tendency to steer towards quasi-experiments[6,7,16]. Three studies (Studies 4, 5, 6) used a one-group pre-test/post-test design. Continuing the trend of quasi-experimental designs, two remaining studies used a one-group pre-test/post-test with a delayed post-test (Study 3) and a pre-test/post-test controlled field experiment (Study 7).

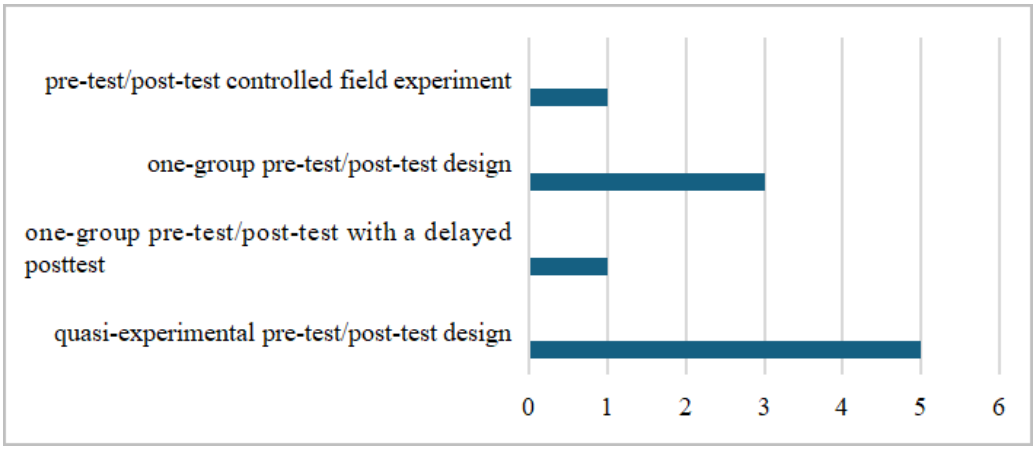

Figure 3. Experimental Designs Represented in the Selected Studies.

Table 2 provides a structured summary of the methodological characteristics of the ten studies included in this systematic review. It outlines each study's geographical location, experimental design, sample size and composition, intervention duration, and instructional strategy or technological tool employed. **Table 3** complements the methodological overview by presenting the core analytical features and outcomes of each study. It details the independent and dependent variables, the statistical methods used for analysis, and the key findings. Effect Sizes (Cohen's d) were estimated for studies reporting mean differences to quantify the magnitude of the intervention effect.

The inclusion of estimated effect sizes (Cohen's d) across the reviewed studies provides a more nuanced understanding of the practical significance of the interventions. Most interventions in this review demonstrated medium to medium-to-large effects, with Study 8 (YouTube-based instruction, $d \approx 0.72$) and Study 2 (resynthesized self-produced stimuli, $d \approx 0.70$) showing powerful practical impacts. These findings suggest that technology-enhanced, personalized, and multimodal approaches may yield more substantial gains in EFL pronunciation.

Table 2. Summary of the Study Data (1).

Study	Location	Experimental Design	Sample (Size, Control Group)	Duration	Intervention
1	China	quasi-experimental pre-test/post-test	80 high-school students Yes	3 months	Speech visualization technology that provided visual feedback (CE waveform and PP2).
2	China	quasi-experimental pre-test/post-test	66 university students Yes	3 months	The use of custom English intonation training courseware (Lectora Inspire v17).
3	Taiwan	single-group pre-test/post-test with a delayed post-test	19 university students Not applicable	1 month	Participants used a robot-tutoring system to read aloud articles, diagnose errors, and practice corrections.

Table 2. *Cont.*

Study	Location	Experimental Design	Sample (Size, Control Group)	Duration	Intervention
4	Indonesia	one-group pre-test/post-test design	8 college students -	7 weeks	Explicit Phonics instruction using reading texts, voice recordings, and playback.
5	Palestine	one-group pre-test/post-test design	66 university students -	4 months	Recording and submitting dialogues using the app, focusing on specific themes.
6	India	one-group pre-test/post-test design	32 teacher trainees -	21 days	Participants underwent training focused on improving pronunciation and oral skills through targeted modules.
7	Japan	pre-test/post-test controlled field experiment	91 elementary students No	2 months	Syllable training and sentence stress training using visual aids, music, and rhythmic patterns.
8	Jordan	quasi-experimental pre-test/post-test design	80 university students Yes	16 weeks	Participants used guided YouTube videos, discussions, and structured tasks, progressing from simple to complex.
9	North Macedonia	quasi-experimental pre-test/post-test design	40 university students Not mentioned	1 month	Using orthographic rules for stress placement instruction. Use of tools (e.g., YouGlish, Vocaroo) for practice and feedback.
10	Taiwan	quasi-experimental pre-test/post-test design	56 elementary students Yes	7 weeks	Participants used speech recognition systems.

Table 3. Summary of the Study Data (2).

Study	Variables (Independent/Dependent)	Statistical Analysis	Key Findings	Effect Size (Cohen's d)
1	Implementation of speech visualization technology/Pronunciation accuracy and fluency	Independent-sample t-tests using SPSS	EG improved significantly in pronunciation accuracy (mean score 4.59 vs. 4.22, $p = 0.027$) and overall IRA scores (mean score 8.31 vs. 7.88, $p = 0.045$).	≈0.60 (medium)
2	Resynthesized self-produced stimuli/Intonation choice accuracy and phonetic realization quality	Independent-sample t-tests for group comparisons. Inter-rater reliability verified using Pearson's Correlation Coefficient	EG showed significant improvements in intonation accuracy and phonetic realization quality compared to CG. EG scores were closer to native speaker standards.	≈0.70 (medium to large)
3	Robot-tutoring system used for self-learning/Word accuracy rates	One-way repeated-measures ANOVA, Bonferroni post hoc tests	After the intervention, there was a spike in accuracy improvement as well as error reduction.	≈0.50 (medium)
4	Phonics teaching materials/Improvement in pronunciation	-	Although the improvement was insignificant, more than half of the sample could recall Phonics lessons, demonstrating retention of the material and silent letters.	≈0.45 (small to medium)
5	Application of the Google Assistant Conversation App/Improvements in speaking skills	Paired-samples t-tests	Significant improvements were observed among all sub-skills, including pronunciation. There was increased confidence, enhanced engagement, and positive feedback towards the app.	≈0.55 (medium)
6	Training targeting phonological and phonetic awareness/Improvements in pronunciation	The Wilcoxon signed-rank test	Post-intervention, a significant improvement was observed in all assessed attributes.	≈0.58 (medium)

Table 3. *Cont.*

Study	Variables (Independent/Dependent)	Statistical Analysis	Key Findings	Effect Size (Cohen's d)
7	Chant-based instruction/Improvements on the segmental and suprasegmental level	Dependent t-tests, ANOVA, Tukey HSD post hoc tests, and multiple regression analysis	Significant improvements were observed in segmental features, sentence stress, and intelligibility, while segmental features had a more substantial impact on intelligibility.	≈0.62 (medium)
8	Teaching method (YouTube videos vs. traditional textbook)/Improvements in pronunciation, fluency, coherence, grammar, and lexical resource	Paired-sample t-tests, Independent Sample T-Tests, and One-Way ANOVA	The experimental group showed statistically significant improvement, especially in pronunciation, followed by fluency and coherence.	≈0.72 (medium to large)
9	An intervention involving explicit instruction of four orthographic word-stress rules/Improved ability to predict and apply correct word stress in polysyllabic words	-	Participants reported improved pronunciation and satisfaction with the employed approach.	≈0.40 (small to medium)
10	Types of intervention (DA-SR or CF-SR)/English speaking skill improvements, learning anxiety, and cognitive load	One-way ANCOVA	Both groups improved significantly, while in the EG, English class performance anxiety and the fear of ambiguity were also reduced.	≈0.65 (medium to large)

Beyond regional distribution and experimental design, the selected studies varied significantly in terms of intervention strategies and targeted pronunciation features. Several studies (e.g., Studies 1, 2, and 3) emphasized technological innovation, incorporating tools like speech visualization software, PRAAT-based feedback, and robot tutoring systems. These interventions often yielded significant improvements in pronunciation accuracy and intonation control, indicating a promising direction for digital integration in pronunciation instruction. In contrast, Studies 4 and 7 utilized Phonics instruction and chant-based activities, approaches that are more grounded in traditional and auditory repetition-based methods. These studies still reported measurable improvements in rhythm and speech intelligibility, highlighting the continued relevance of low-tech, accessible strategies.

5. Discussion

5.1. Methodological Trends

One of the fundamental findings of this systematic review is the overwhelming dominance of quasi-experimental designs in recent empirical investigations on pronunciation instruction in EFL contexts. This result directly addresses the first focus of the review, which concerned the types of experimental frameworks currently employed in this area of research. Across all ten studies analyzed, non-random assignment frameworks were consistently used, indicating a clear methodological trend and echoing the practical constraints noted by Huo and Wang [8] and Metruk [9]. There are several reasons, but authors often cite problems with random assignment, the sensitivity of the educational environment, practicality, and the complexity of variables in education, which often leads researchers to prefer quasi-experiments over randomized experiments [6,7,10–12,33]. These methodological choices align with broader theoretical understandings of L2 speech acquisition, such as Flege's Speech Learning Model [34], which emphasizes the importance of perceptual training and articulatory feedback in improving L2 phonological competence. The consistent reliance on quasi-experiments reflects an attempt to capture the nuanced, incremental nature of pronunciation development within authentic classroom contexts.

5.2. Intervention Strategies

The current systematic review includes a broader technological integration – a wider range of tech tools (e.g., robot tutors, speech recognition, AI apps), showing a more diverse and modern approach than the other two. It highlights affective outcomes like reduced anxiety and increased motivation, which were less emphasized in the other reviews [8,9]. A particularly intriguing finding and a strength of the reviewed studies was the use of innovative intervention strategies to improve the pronunciation of EFL learners. Specifically, they used speech visualization tools, speech recognition systems, and resynthesized self-produced stimuli and PRAAT

software[22,23,26]. Two of the reviewed studies used state-of-the-art technological interventions, using a robot-tutoring system and an AI-powered application, Google Assistant Conversation App[24,25]. Interestingly, speech recognition systems and AI-powered tools were found to significantly outperform more traditional audio-only methods in fostering learner engagement and pronunciation gains. This supports the findings of Derwing and Munro[28], who emphasized the need for multimodal feedback in L2 pronunciation instruction.

5.3. Limitations

A central limitation of this review lies in the geographic concentration of the included studies, with the vast majority originating from Asian countries. While this reflects strong institutional support and policy-driven emphasis on English language education in regions such as China, Japan, Taiwan, and Indonesia, it inevitably narrows the cultural and educational scope of the findings. The specific teaching environments, learner expectations, and technological infrastructure in these contexts may not represent conditions in other parts of the world. As a result, the transferability of the reviewed intervention strategies to underrepresented regions such as Africa, Latin America, or Eastern Europe remains uncertain. Future research should therefore diversify geographic representation to capture cross-cultural variability better and promote globally applicable pedagogical practices.

In addition to regional bias, the methodological quality of the underlying studies also presents several challenges. Many of the reviewed studies exhibited methodological weaknesses, including small sample sizes, short intervention durations, and the absence of control groups. These design issues limit the strength of causal claims and reduce the reliability of aggregated conclusions. Furthermore, very few studies employed longitudinal designs, making it difficult to determine whether improvements in pronunciation are sustained over time.

Finally, this review excluded grey literature such as conference papers, theses, and preprints. Although this decision ensured consistency in methodological quality, it may have introduced publication bias by favoring studies with statistically significant outcomes.

5.4. Pedagogical Implications

Compared to prior systematic reviews, such as Huo and Wang[8] and Metruk[9], the present review emphasizes the pedagogical value of integrating diverse, multimodal, and interactive tools in EFL pronunciation instruction across varied learner populations and contexts. The reviewed studies have shown that EFL learners' pronunciation has improved through the use of innovative tools and methods. This finding confirms the need for continuous modernization, technology implementation, and unconventional education methods to improve learning outcomes. Pedagogical implications also include the findings on the need for tailored and interactive methods for teaching English pronunciation, or the benefits of personalized feedback[23,26].

Another notable theme emerging from the analysis was the importance of learner perception and affective outcomes. Researchers in Studies 5, 9, and 10 incorporated qualitative elements (e.g., focus groups, diary entries, and anxiety measures) to capture learners' subjective experiences. These findings revealed not only improvements in measurable pronunciation features but also increased learner motivation, confidence, and reduced language anxiety. This convergence of cognitive and affective outcomes strengthens the argument for incorporating emotionally supportive strategies into pronunciation instruction as suggested by Kralova et al.[27].

Based on the findings, several actionable recommendations can be made for educators:

- Teachers should integrate speech visualization tools (e.g., CE waveform, PRAAT) to provide immediate, visual feedback on pronunciation, but balance them with human interaction to maintain communicative authenticity.
- Incorporating AI-powered applications and speech recognition systems can enhance learner engagement and provide scalable feedback, especially in large classrooms.
- Educators should adopt multimodal instruction that combines auditory, visual, and kinesthetic elements to address diverse learner needs.
- Teacher training programs should include modules on pronunciation pedagogy and the effective use of technology in pronunciation instruction.
- Pronunciation instruction should be embedded in com-

municative tasks to ensure contextualized learning and reduce learner anxiety.

6. Conclusions

This systematic review highlights the transformative potential of experimental research in EFL pronunciation instruction, particularly through the integration of innovative technologies and multimodal pedagogies. The reviewed studies demonstrate promising outcomes in pronunciation accuracy, fluency, and learner engagement. However, the field still faces challenges related to methodological consistency, limited geographic representation, and short-term intervention durations. To advance the field, future research should be structured around the following themes:

- **Technology**: Investigation of the comparative effectiveness of emerging tools such as AI-powered tutors, speech visualization software, and mobile applications across diverse learner populations. Prior studies have shown that such tools can significantly enhance pronunciation outcomes and learner motivation [22,25].
- **Longitudinal Designs**: Conducting long-term studies to assess the sustainability of pronunciation gains and the delayed effects of interventions. As noted by Metruk [9], the lack of longitudinal data limits understanding of lasting impacts. However, the predominance of quasi-experimental designs reflects a trade-off between internal and ecological validity. While such designs are more feasible in real-world educational settings, they limit the ability to draw causal inferences due to the absence of random assignment. To strengthen future research, incorporating randomized controlled trials and adopting mixed-methods designs are recommended to capture both quantitative outcomes and learner experiences. Researchers are also encouraged to integrate delayed post-tests and longitudinal follow-ups to evaluate the durability of learning outcomes and determine whether short-term pronunciation gains translate into long-term linguistic development.
- **Cross-Cultural Comparisons**: Exploration of how sociocultural and linguistic contexts influence the efficacy of pronunciation instruction, particularly in underrepresented regions such as Africa, Latin America, and Eastern Europe. This would address the regional bias identified in current literature and improve global applicability.

From a policy perspective, educational ministries and funding agencies should fund large-scale trials of AI-driven pronunciation tutors in varied EFL contexts to evaluate scalability, equity, and effectiveness; promote the inclusion of pronunciation-focused modules in teacher training curricula, ensuring educators are equipped with both pedagogical and technological competencies, and allocate resources for the development of open-access pronunciation tools tailored to local linguistic and cultural needs, supporting equitable access to high-quality instruction. Addressing these research and policy priorities, the field can move toward more inclusive, evidence-based, and context-sensitive approaches to EFL pronunciation instruction.

Author Contributions

Conceptualization, R.K. and Z.K.; methodology, R.K.; validation, R.K. and Z.K.; formal analysis, R.K.; investigation, R.K.; resources, R.K.; data curation, R.K.; writing—original draft preparation, R.K.; writing—review and editing, Z.K.; visualization, Z.K.; supervision, Z.K.; funding acquisition, Z.K. All authors have read and agreed to the published version of the manuscript.

Funding

This work was supported by the KEGA Agency of the Ministry of Education, Research, Development and Youth of the Slovak Republic under Grant KEGA 001UKF-4/2024.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

All of the data that support the findings of this study are available in the main text.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Szpyra-Kozłowska, J., 2015. Pronunciation in EFL Instruction: A Research-Based Approach. Multilingual Matters: Bristol, UK. 249 p.

[2] Zhang, Q., 2009. Affecting Factors of Native-Like Pronunciation: A Literature Review. Korea Education & Research Institute. 27(2), 33–52.

[3] Celce-Murcia, M.; Brinton, D.M.; Goodwin, J.M., 2010. Teaching Pronunciation: A Course Book and Reference Guide. Cambridge University Press: New York, USA. 556 p.

[4] Szyszka, M., 2017. Pronunciation Learning Strategies and Language Anxiety: In Search of an Interplay. Springer International Publishing: Cham, Germany. 224 p.

[5] Vancova, H., 2020. Pronunciation Practices in EFL Learning: Perspectives of Teachers and Students. Gaudeamus: Hradec Kralove, Czech Republic. 89 p.

[6] Cohen, L.; Manion, L.; Morrison, K., 2018. Research Methods in Education, 8th ed. Routledge: New York, USA. 916 p.

[7] Creswell, J.W.; Guetterman, T.C., 2019. Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research, 6th ed. Pearson: New Jersey, USA. 655 p.

[8] Huo, S., Wang, S., 2017. The Effectiveness of Phonological-Based Instruction in English as a Foreign Language Students at Primary School Level: A Research Synthesis. Frontiers in Education, 2. DOI: https://doi.org/10.3389/feduc.2017.00015

[9] Metruk, R., 2024. Mobile-Assisted Language Learning and Pronunciation Instruction: A Systematic Literature Review. Education and Information Technologies, 29(13), 16255–16282. DOI: 10.1007/s10639-024-12453-0

[10] Scott, D.; Usher, R., 2011. Researching Education: Data, Methods and Theory in Educational Enquiry, 2nd ed. Continuum International Publishing Group: New York, USA. 224 p.

[11] Gopalan, M., Rosinger, K., Ahn, J.B., 2020. Use of Quasi-Experimental Research Designs in Education Research: Growth, Promise, and Challenges. Review of Research in Education. 44(1), 218–243. DOI: 10.3102/0091732X20903302

[12] Shadish, W.R.; Cook, T.D.; Campbell, D.T., 2002. Experimental and Quasi-Experimental Designs for Generalized Causal Inference. Wadsworth Cengage Learning: Belmont, USA. 623p.

[13] Campbell, D.T.; Stanley, J.C., 1963. Experimental and Quasi-Experimental Designs for Research. Wadsworth: Belmont, USA. 84 p.

[14] Mark, M.M.; Lenz-Watson, A.L., 2011. Ethics and the Conduct of Randomized Experiments and Quasi Experiments in Field Settings. Handbook of Ethics in Quantitative Methodology. Routledge: New York, USA. pp. 185–209.

[15] Cham, H., Lee, H., Migunov, I., 2024. Quasi-Experimental Designs for Causal Inference: An Overview. Asia Pacific Education Review, 25(3), 611–627. DOI: 10.1007/s12564-024-09981-2

[16] McMillan, J.H.; Schumacher, S., 2014. Research in Education: Evidence-Based Inquiry, 7th ed. Pearson Education: Harlow, UK. 540 p.

[17] Gozali, I., 2019. Developing Phonics Material to Improve the Spoken English of Indonesian Tertiary Students. KnE Social Sciences. 3(10), 379. DOI: https://doi.org/10.18502/kss.v3i10.3920

[18] Hakozaki, Y., Nakagawa, Y., 2020. Teaching Stress-Timed Rhythm of English at the Japanese Elementary School Level: Focusing on the Effects of Using Chants. Journal of Foreign Language Education. 27(21), 173–201.

[19] Kirkova-Naskov, A., Duckinoska-Mihajlovska, I., 2023. Explicit Instruction of Pronunciation Learning Strategies and Word-Stress Rules: Examining Learners' Reflections from Diary Entries. PALIM. 8(16), 187–198. DOI: https://doi.org/10.46763/PALIM23816187kn

[20] Saed, H.A., Haider, A.S., Al-Salman, S., et al., 2021. The Use of YouTube in Developing the Speaking Skills of Jordanian EFL University Students. Heliyon. 7(7), e07543. DOI: 10.1016/j.heliyon.2021.e07543

[21] Diwakar, P., Kennedy, A.T., 2024. Effect of Phonological and Phonetic Interventions on Proficiency in English Pronunciation and Oral Reading. Education Research International. 1–18. DOI: 10.1155/2024/9087087

[22] Liu, X., Wu, D., Ye, Y., et al., 2020. Improving Accuracy in Imitating and Reading Aloud via Speech Visualization Technology. International Journal of Emerging Technologies in Learning. 15(8), 144. DOI: 10.3991/ijet.v15i08.11475

[23] Li, Z., Lian, A.P., Yodkamlue, B., 2020. Learning English Intonation Through Exposure to Resynthesized Self-Produced Stimuli. GEMA Online Journal of Language Studies. 20(1), 54–76. DOI: 10.3991/ijet.v15i08.11475

[24] Hong, Z.W., Tsai, M.H.M., Ku, C.S., et al., 2024. Utilizing Robot-Tutoring Approach in Oral Reading to Improve Taiwanese EFL Students' English Pronunciation. Cogent Education. 11(1), 2342660. DOI: 10.1080/2331186X.2024.2342660

[25] Qassrawi, R.M., ElMashharawi, A., Itmeizeh, M., et al., 2024. AI-Powered Applications for Improving EFL

Students' Speaking Proficiency in Higher Education. Forum for Linguistic Studies. 6(5), 535–549. DOI: 10.30564/fls.v6i5.6966

[26] Chen, C.H., Koong, C.S., Liao, C., 2022. Influences of Integrating Dynamic Assessment into a Speech Recognition Learning Design to Support Students' English Speaking Skills, Learning Anxiety and Cognitive Load. Educational Technology & Society. 25(1). DOI: 10.30191/ETS.202201_25(1).0001

[27] Kralova, Z., Skorvagova, E., Tirpakova, A., et al., 2017. Reducing Student Teachers' Foreign Language Pronunciation Anxiety Through Psycho-Social Training. System. 65, 49–60. DOI: 10.1016/j.system.2017.01.001

[28] Derwing, T.; Munro, M., 2015. Pronunciation Fundamentals: Evidence-based Perspectives for L2 Teaching and Research. John Benjamins Publishing Company. DOI: https://doi.org/10.1075/lllt.42

[29] Page, M.J., McKenzie, J.E.; Bossuyt, P.M.; et al., 2021. The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. BMJ.

[30] Nundy, S., Kakar, A., Bhutta, Z.A., 2022. How to Practice Academic Medicine and Publish from Developing Countries? A Practical Guide. Springer Nature Singapore: Singapore. 277–281. DOI: 10.1007/978-981-16-5248-6

[31] Pashmforoosh, R., 2024. English Accents in the Context of English as an International Language (EIL): Persian-Speaking English Language Teachers' Perceptions. In: Saeli, H. (ed.). Handbook of Teaching and Learning Persian as a Second Language. Springer Nature Singapore: Singapore. pp. 1–19.

[32] Pourhosein Gilakjani, A., 2012. The Significance of Pronunciation in English Language Teaching. English Language Teaching. 5(4). DOI: 10.5539/elt.v5n4p96

[33] Nichols, A.L., Edlund, J.E., 2023. The Cambridge Handbook of Research Methods and Statistics for the Social and Behavioral Sciences. Volume 1: Building a Program of Research. Cambridge University Press: International. 817 p.

[34] Flege, J.E., 1995. Second Language Speech Learning: Theory, Findings and Problems. In: Strange, W. (ed.). Speech Perception and Linguistic Experience: Issues in Cross-Language Research. York Press: Baltimore, USA. pp. 233–277.