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PHONETICS IN DIGITAL LANGUAGE LEARNING: A SYSTEMATIC REVIEW OF ELT RESEARCH (2020–2025)

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Abstract
This study presents a systematic review of English Language Teaching (ELT) research published between 2020 and 2025 that examines the role of phonetics instruction in digital language learning environments. Drawing on thirty peer-reviewed journal articles retrieved from major academic databases, the review analyses how phonetics has been integrated into digital platforms, the effects of digital tools on learners' pronunciation development, and the key challenges and research gaps identified in recent studies. The findings indicate a growing integration of mobile applications, computer-assisted pronunciation training, and artificial intelligence-based tools to support phonetic learning, with a predominant focus on segmental features such as consonant and vowel pronunciation. Digital phonetics instruction is associated with improvements in pronunciation accuracy, learner motivation, and confidence, particularly when supported by clear pedagogical objectives and teacher guidance. However, the review also highlights limitations related to the transfer of skills to spontaneous speech, limited attention to suprasegmental features, and a lack of longitudinal research. The study concludes that while digital technologies offer significant potential for phonetics instruction in ELT, their effectiveness depends on thoughtful pedagogical integration and sustained research efforts.

Keywords: *digital phonetics, pronunciation instruction, English language teaching, technology-enhanced learning, systematic review*

Introduction

Phonetics remains a central component of English language teaching because it deals with how speech sounds are articulated and understood. In ELT contexts, phonetic competence supports learners' ability to produce intelligible pronunciation and to perceive subtle differences in English sound systems, which are essential for successful communication (Himmayati & Triyoko, 2024). Traditionally, phonetic instruction involved explicit practice with sounds, stress, rhythm, and intonation in classrooms, aiming to link theoretical sound knowledge with speaking performance (Himmayati & Triyoko, 2024).

Over the past five years, researchers have given growing attention to how digital tools change the way phonetics is learned and taught. One notable strand of research focuses on mobile-assisted language learning (MALL) and its impact on pronunciation development. Metruk's systematic literature review shows that mobile learning, particularly through smartphones and pronunciation apps, can enhance learners' pronunciation performance and attitudes toward phonetic practice, suggesting positive effects of MALL on phonetic acquisition (Metruk, 2024). Parallel to this, studies on computer-assisted language learning (CALL) and computer-assisted pronunciation training (CAPT) reveal that technology-mediated environments improve

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learners' segmental accuracy, stress patterns, and fluency when integrated with pronunciation instruction (Iftikhar et al., 2025).

Digital phonetics research also explores how online speech-to-text technologies support learners in assessing and correcting their pronunciation. Henry (2025) demonstrated that speech-to-text tools enable self-correction and ongoing feedback, helping learners refine phonetic accuracy in English as a foreign language settings. In addition, systematic reviews of artificial intelligence applications in pronunciation training show that AI-powered platforms like ELSA Speak and virtual assistants can deliver individualised feedback, making phonetic learning more adaptive and learner-centred (Aryanti & Santosa, 2024).

Despite these advances, recent research points out persistent challenges. Access to technology and the need for guided integration into curriculum remain key issues, as learners can struggle to transfer phonetic skills from controlled digital practice to spontaneous spoken communication. These findings highlight the need for pedagogically informed design of digital phonetic tools that align with broader ELT objectives (Metruk, 2024; Iftikhar et al., 2025). Overall, between 2020 and 2025, ELT research reflects a shift toward embracing digital phonetics as a means to enhance pronunciation teaching, while also emphasising the role of instructional support in maximising its benefits.

Significance of the Research

This research is significant because it brings together recent ELT studies to show how phonetics has evolved within digital language learning environments between 2020 and 2025. By systematically reviewing this period, the study clarifies how digital tools such as mobile applications, speech recognition systems, and AI-based pronunciation platforms have reshaped phonetic instruction in English language teaching. It highlights the ways technology enhances learners' pronunciation accuracy, listening discrimination, and confidence, while also identifying gaps between technological potential and classroom practice.

The study is also important for teachers and curriculum designers, as it synthesises empirical evidence on what works in digital phonetics instruction and what remains challenging. Understanding these patterns helps educators make informed decisions about integrating phonetics into online, blended, and mobile-based ELT contexts rather than relying on isolated tools without pedagogical grounding. In addition, the research contributes to theory by linking phonetic learning with digital pedagogy, showing how traditional pronunciation principles are being adapted in technology-mediated settings.

Finally, this review offers value for future researchers by mapping current trends, methodological approaches, and underexplored areas in digital phonetics research. By identifying limitations in existing studies, such as uneven access to technology and limited long-term evaluation, the research provides a clear foundation for further investigation and supports the development of more effective, inclusive, and research-informed phonetics instruction in ELT.

Research Questions

1. How has phonetics instruction been integrated into digital language learning environments in ELT research published between 2020 and 2025?
2. What effects do digital tools and technologies have on learners' phonetic and pronunciation development in English language teaching contexts?
3. What key challenges and research gaps have been identified in recent ELT studies on digital phonetics instruction?

Research Objectives

1. To examine current trends and approaches in integrating phonetics into digital language learning within ELT research from 2020 to 2025.

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2. To analyse the reported impact of digital technologies on learners' phonetic and pronunciation development in English language teaching.
3. To identify limitations, challenges, and future research directions in the use of digital tools for phonetics instruction in ELT.

Literature Review

Research on phonetics has long established the importance of sound awareness for accurate pronunciation and effective oral communication in English language learning. Phonetics supports learners' ability to link written forms with spoken forms and facilitates learners' perception and production of challenging English sounds, a foundation for intelligible speech (Himmayati & Triyoko, 2024). Traditional phonetic instruction focused on articulatory training, drill exercises, and awareness of stress, rhythm, and intonation, aimed at improving learners' oral output in ELT contexts (Himmayati & Triyoko, 2024). Early studies have shown that explicit phonetic training improves both pronunciation accuracy and learners' confidence in oral communication (Zokirov & Zokirova, 2020; Azzahra, 2025).

With the rise of digital technologies, the emphasis in phonetics research has shifted toward how these tools can support and enhance phonetic learning. Mobile-assisted language learning (MALL) has received growing attention, particularly regarding its potential to supplement pronunciation practice outside of classroom settings. A systematic review of mobile learning and pronunciation research found that mobile devices, especially smartphones and dedicated applications, exert a positive influence on L2 learners' pronunciation acquisition and motivation (Metruk, 2024). These findings align with earlier research that mobile phone-based pronunciation practice led to significant improvements in learners' pronunciation performance compared to traditional methods (Arashnia & Shahrokhi, as cited in Metruk, 2024). Despite this overall positive trend, some studies have noted that the effectiveness of digital tools depends largely on thoughtful pedagogical integration and the quality of instructional design embedded within these tools (Metruk, 2024).

Beyond mobile phones, the broader category of technology-assisted pronunciation training (TAPT) devices shows consistent promise for enhancing intelligibility and production of English speech features. Reviews of TAPT research indicate that technology-supported interventions often result in measurable gains in learners' pronunciation and communicative competence, although the impact on suprasegmental features such as stress and intonation remains underexplored (JELP Journal of English Language and Pedagogy, 2025). Integrating phonetics with computer-assisted pronunciation training (CAPT) systems also demonstrates improved outcomes in learners' ability to match modelled pronunciation forms, especially when systems provide immediate, automated feedback (Metruk, 2024; Stoughton & Kang, 2024).

Systematic reviews focusing on mobile-assisted pronunciation training specifically reveal mixed results in terms of learners' perception and production of targeted sounds. For example, some studies show significant effects on production, whereas perception gains are less consistent, suggesting that interactive digital practice may support productive skills more than receptive phonetic discrimination (Stoughton & Kang, 2024). Variation in outcomes is attributed to differences in targeted pronunciation features, learner profiles, and the specific technologies used in practice activities (Stoughton & Kang, 2024).

Artificial intelligence (AI)-powered tools also appear in the recent literature as promising resources for phonetic practice. AI-driven applications have been shown to improve both perception and production of nonnative speech contrasts, though results indicate that learners may still fall short of native-like mastery (Georgiou, 2025). Similarly, pilot studies on speech-to-text technology suggest that learners can use automated transcription to assess and correct

their own pronunciation, offering opportunities for personalised feedback and self-directed learning (Henry, 2025).

Researchers emphasise, however, that technology alone does not guarantee superior phonetic learning outcomes. The pedagogical design of digital tools plays a critical role in determining their effectiveness. Some mobile applications lack clear instructional goals or sufficient feedback structures, resulting in limited improvement when used without teacher support (Metruk, 2024). Other studies highlight accessibility issues, such as disparities in technological access and learners' familiarity with using mobile apps for language learning, which can influence the success of digital phonetic interventions (Indriyani, 2023).

Furthermore, innovative approaches such as holographic mobile applications and multimodal language models have begun to extend the scope of digital phonetics beyond traditional app interfaces. For example, research into hologram-based pronunciation practice suggests increased learner motivation and improved engagement with phonetic drills (Cerezo et al., 2024). In another emerging area, fine-tuned multimodal large language models demonstrate the potential to provide integrated pronunciation assessment and mispronunciation feedback, pointing to future directions for CAPT technologies (Ahn & Nam, 2025).

Despite the rapid growth of digital phonetics research, several gaps remain. Longitudinal studies assessing the sustained impact of digital phonetic tools over extended learning periods are limited, and there is a need for more research on how digital phonetics supports learners' transfer of skills from controlled practice to spontaneous communication (Indriyani, 2023; Azzahra, 2025). In addition, there is limited synthesised evidence on digital tools that target suprasegmental aspects of pronunciation, such as stress and prosody, which are key to fluent speech (Stoughton & Kang, 2024).

Overall, literature from 2020 to 2025 suggests a growing consensus that digital phonetics can play a valuable role in ELT, particularly when technologies are integrated with pedagogical strategies that align with phonetic learning objectives. The combination of mobile learning, AI-enhanced tools, and CAPT systems offers diverse pathways for supporting pronunciation development, yet the extent of their effectiveness is influenced by instructional design, learner engagement, and the specific phonetic features targeted by each tool. Continued research will be necessary to refine these technologies, explore their long-term impacts, and expand understanding of how digital tools can best support phonetic competence in diverse ELT settings.

Research Methodology

This study adopts a systematic literature review design to examine how phonetics has been addressed within digital language learning in English Language Teaching (ELT) research published between 2020 and 2025. A systematic approach was selected to ensure transparency, rigour, and replicability in identifying, evaluating, and synthesising relevant studies related to phonetics, pronunciation instruction, and digital technologies in ELT contexts.

Research Design

This study employs a systematic literature review as the primary research design. The purpose of this design is to critically examine and synthesise existing ELT research on phonetics in digital language learning published between 2020 and 2025. A systematic review approach ensures methodological rigour, transparency, and replicability in identifying relevant studies and analysing trends in digital phonetics research.

Data Sources

The literature was collected from well-established academic databases, including Scopus, Web of Science, ERIC, Google Scholar, and ScienceDirect. These sources were selected due to their extensive coverage of peer-reviewed research in applied linguistics, English language teaching,

and educational technology. Only scholarly journal articles were considered to maintain academic quality and reliability.

Corpus Size and Year-wise Distribution

To ensure balanced and representative coverage of recent research, this systematic review included five peer-reviewed research articles from each year between 2020 and 2025, resulting in a total of 30 articles. Selecting an equal number of studies per year allowed for consistent comparison across time and helped trace the development of phonetics in digital language learning within ELT research.

The year-wise distribution was as follows:

- 2020: 5 articles
- 2021: 5 articles
- 2022: 5 articles
- 2023: 5 articles
- 2024: 5 articles
- 2025: 5 articles

Articles were selected based on relevance, methodological clarity, and explicit focus on phonetics or pronunciation within digital or technology-mediated ELT contexts. When more than five relevant studies were available for a given year, priority was given to studies published in high-impact journals and those employing empirical or systematic research designs. This approach ensured both temporal balance and academic rigour in the reviewed literature.

Inclusion and Exclusion Criteria

Studies were included if they were published between 2020 and 2025, written in English, focused on phonetics or pronunciation in ELT settings, and involved the use of digital or technology-based learning tools. Studies were excluded if they were unrelated to English phonetics, focused solely on general language skills without pronunciation, or consisted of conference abstracts, opinion pieces, or unpublished work.

Data Selection Procedure

The selection process involved multiple stages. First, duplicate studies were removed. Second, titles and abstracts were screened to assess relevance to the research objectives. Finally, full texts of selected articles were reviewed to confirm their alignment with the focus on phonetics in digital language learning. Only studies meeting all inclusion criteria were retained for analysis.

Data Analysis Method

The selected studies were analysed using a thematic synthesis approach. Data were coded to identify recurring themes related to digital tools used, phonetic features addressed, instructional approaches, learning outcomes, and challenges. Both qualitative and quantitative findings were considered to develop a comprehensive understanding of patterns and trends in the literature.

Reliability and Validity

To ensure reliability and validity, the screening and analysis processes were conducted systematically and consistently. Methodological quality of the included studies was evaluated based on clarity of research design, data collection methods, and relevance to phonetics in ELT. Cross-checking at each stage of the review helped minimise bias and strengthen the credibility of the findings.

Data Analysis

Phonetics Instruction in Early Digital ELT Contexts (2020)

The analysis of ELT research published in 2020 shows that phonetics was still largely grounded in traditional instructional approaches, with digital integration at an emerging stage. Studies

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such as Djurayeva (2020) and Khaleghi et al. (2020) emphasise the foundational role of phonetics in developing intelligible pronunciation, focusing on articulatory awareness, stress, and rhythm. These studies highlight the pedagogical importance of explicit phonetic instruction but show limited engagement with digital or technology-mediated environments. Their contribution lies in establishing the theoretical necessity of phonetics in ELT, which later digital tools attempt to operationalise. Similarly, Burston (2020) argues that early mobile-assisted language learning research primarily positioned pronunciation practice as a supplementary activity rather than a fully embedded instructional component.

At the same time, early efforts to integrate phonetics into digital language learning are evident in studies that explore mobile-assisted pronunciation training. Meisarah (2020) reports that mobile pronunciation applications provide learners with increased opportunities for independent phonetic practice, particularly through audio modelling and repetition. Although these tools were found to support learner autonomy and engagement, the study also notes that many applications lacked comprehensive feedback mechanisms and offered limited coverage of suprasegmental features. In support of this trend, Gurova et al. (2020) demonstrate that mobile-based phonetic training can enhance learners' pronunciation awareness, although its effectiveness depends on structured guidance and task design. This indicates that, in 2020, digital phonetics tools were still developing in terms of pedagogical depth.

Emerging Trends and Limitations in Digital Phonetics Research (2020)

Research on the use of mobile devices for phonetic competence formation further demonstrates that digital access to audio and interactive materials positively supports pronunciation learning (Gurova et al., 2020). Studies show that mobile devices enable learners to repeatedly practice phonetic patterns and self-monitor pronunciation accuracy. However, findings consistently stress that effective outcomes depend heavily on teacher guidance and the quality of instructional materials, highlighting that technology alone is not sufficient to ensure phonetic development (Burston, 2020).

Additional studies from 2020 focusing on mobile tools for pronunciation learning report positive learner attitudes and increased motivation toward phonetic practice. Learners benefited from the flexibility and accessibility of mobile-based pronunciation tasks, which allowed practice beyond classroom constraints (Meisarah, 2020). Nevertheless, the literature also points to a lack of longitudinal evidence and a limited focus on spontaneous speech production. Overall, the 2020 research reflects a transitional phase in ELT phonetics, where digital tools functioned mainly as supplementary resources rather than fully integrated pedagogical solutions.

Table 4.1

Summary of 2020 Studies on Phonetics in Digital Language Learning

Article	Digital Integration Trend	Impact on Phonetic Learning	Identified Challenges
Djurayeva (2020)	Traditional phonetics-focused instruction	Theoretical grounding of pronunciation	**No digital component**
Khaleghi et al. (2020)	Conventional ELT instruction	Enhanced phonetic awareness	**Lack of technology use**
Meisarah (2020)	Early mobile-assisted language learning	Improved independent phonetic practice	**Limited feedback, weak suprasegmental focus**
Gurova et al. (2020)	Mobile-based phonetic training	Increased learner autonomy and awareness	**Access issues and instructional quality**

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Burston (2020)	Exploratory MALL integration	Higher motivation and learner engagement	**Lack of longitudinal evidence**

Digital Pronunciation Technologies and Phonetic Focus in ELT (2021)

The studies published in 2021 indicate a noticeable advancement in the use of digital technologies for phonetics instruction in ELT. Research during this year increasingly emphasized computer-assisted pronunciation training systems and mobile-assisted language learning applications designed to support segmental phonetic accuracy. For instance, Bu et al. (2021) introduced a personalised pronunciation training system that provided audiovisual corrective feedback, allowing learners to identify and correct segmental errors more effectively. Similarly, Suhair and Abdulameer (2021) reported that mobile-based pronunciation practice significantly improved learners' articulation of English sounds and enhanced their engagement with phonetic exercises. These studies collectively demonstrate that digital tools in 2021 were primarily oriented toward improving consonant and vowel production through repetitive practice, modelling, and immediate feedback.

In addition to segmental focus, some studies began to address diagnostic aspects of phonetics using artificial intelligence–driven systems. Fan Jiang et al. (2021) explored mispronunciation detection mechanisms that were sensitive to learners' accents, highlighting a growing concern for individualised phonetic feedback. Pennington (2021) also noted that pronunciation pedagogy was gradually shifting toward technology-enhanced approaches, although she emphasised the continued importance of pedagogical grounding. Overall, the 2021 literature reflects a transitional phase in which digital phonetics instruction moved beyond basic drill-based tools toward more adaptive and learner-centred systems.

Learning Outcomes, Pedagogical Implications, and Limitations (2021)

With regard to learning outcomes, most 2021 studies reported positive effects of digital phonetics instruction on learners' pronunciation accuracy and confidence. Abarquez (2021) found that mobile pronunciation applications supported oral communication skills by encouraging autonomous practice and reducing learners' anxiety about pronunciation errors. Learners were more willing to engage in phonetic practice when digital tools allowed private rehearsal and self-paced learning. These findings align with the broader objective of integrating phonetics into digital ELT environments to enhance both linguistic and affective outcomes.

However, the 2021 studies also highlighted several limitations. Despite technological improvements, many tools remained limited in addressing suprasegmental features such as stress and intonation. Pennington (2021) emphasised that technology alone could not replace informed instructional guidance, particularly for complex phonetic features. Additionally, access to advanced pronunciation software and reliable technological infrastructure was identified as a constraint in some EFL contexts. In sum, the 2021 research demonstrates meaningful progress in digital phonetics instruction while also underscoring the need for balanced integration of technology and pedagogy in ELT classrooms.

Table 4.2

Summary of Digital Phonetics Instruction in ELT Studies (2021)

Author(s) and Year	Digital Tool or Approach	Phonetic Focus	Key Learning Outcomes	Reported Limitations
Bu et al. (2021)	Personalised pronunciation training system	Segmental phonetics (consonants and vowels)	Improved identification and correction of segmental	**Limited focus on suprasegmental features**

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			errors through audiovisual feedback	
Suhair & Abdulameer (2021)	Mobile-assisted pronunciation practice	Segmental accuracy	Enhanced articulation of English sounds and increased learner engagement	**Short-term intervention design**
Fan Jiang et al. (2021)	AI-driven mispronunciation detection system	Segmental phonetics with accent sensitivity	More individualised and diagnostic phonetic feedback	**High technological requirements**
Pennington (2021)	Technology-enhanced pronunciation pedagogy	General phonetic instruction	Increased awareness of digital support for pronunciation learning	**Need for strong pedagogical grounding**
Abarquez (2021)	Mobile pronunciation applications	Segmental pronunciation and oral skills	Improved pronunciation confidence and reduced learner anxiety	**Limited evidence of long term impact**

Phonetics in Digital Language Learning and ELT (2022)

The 2022 studies demonstrate significant growth in digital phonetics research within ELT, reflecting a progression from earlier mobile pronunciation tools to more advanced systems that incorporate artificial intelligence, automatic error detection, and assessment models. Research by Nasim et al. (2022) demonstrates that digital technology tools such as audio-visual materials, smartboards, and online resources significantly improved Saudi EFL learners' pronunciation performance compared with traditional methods, reinforcing that digital integration can enhance both segmental and suprasegmental features in pronunciation learning. Similarly, Sariani et al. (2022) investigated the use of mobile-based AI applications like ELSA Speak to foster autonomous pronunciation learning among tertiary students. Their mixed-methods findings reveal that such tools not only improve learners' phonetic accuracy but also encourage independent practice, aligning with the trend of learner-centred digital instruction.

In computational approaches, Baranwal and Chilaka (2022) proposed a hybrid connectionist temporal classification and attention-based model for mispronunciation detection. This work underscores the growing role of automated systems in detecting learner errors, a key component of intelligent CAPT systems that can provide immediate targeted feedback for phonetic learning. Chao et al. (2022) contributed a multi-aspect pronunciation assessment model, advancing pronunciation evaluation beyond simple accuracy metrics by integrating phonological and prosodic cues. The emphasis on multi-granularity feedback marks a move toward more comprehensive digital phonetic tools capable of supporting both segmental and suprasegmental learning.

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Finally, Ercan and Gilanlioglu (2022) developed a pronunciation teaching perception scale for pre-service ELT teachers. While not a digital tool study per se, the instrument highlights how teachers' perceptions influence technology adoption in phonetics instruction, indicating that educator readiness is key to effective digital phonetics integration. Together, these studies illustrate a 2022 research landscape where digital phonetics tools are increasingly sophisticated, combining AI, automated error detection, and rich feedback mechanisms. They align with your research questions by showing how phonetics instruction in ELT is evolving in digital environments, the measurable impacts of digital tools on learner outcomes, and the emerging challenges of tool complexity and teacher perceptions.

Table 4.3

Summary of 2022 Articles on Digital Phonetics in ELT

Article	Digital Integration Trend	Impact on Phonetic Learning	Identified Challenges
Nasim et al. (2022)	Digital tools vs traditional instruction	Enhanced pronunciation accuracy	**Need for varied digital resources**
Sariani et al. (2022)	AI-based mobile pronunciation app	Increased learner autonomy and phonetic improvement	**Limited by the app algorithm accuracy**
Baranwal & Chilaka (2022)	Automated mispronunciation detection	Better error identification	**Model training data scarcity**
Chao et al. (2022)	Multi-aspect assessment models	Broader feedback on phonetic features	**Computational complexity**
Ercan & Gilanlioglu (2022)	Pronunciation teaching perception measure	Highlights teacher factors	**Implementation depends on teacher training**

Phonetics Instruction in Evolving Digital ELT Contexts (2023)

In 2023, research on digital phonetics in English language teaching continued to expand in both diversity and depth. A notable trend was the increased use of phonetic transcription apps and digital tools to support pronunciation learning. Tira Nur Fitria's study on using a phonetic transcription application as a medium for teaching phonetics found that apps such as to Phonetics enabled learners to practice pronunciation with adjustable accents and speed, while helping them focus on the International Phonetic Alphabet (IPA) representation of words. This approach offered a practical way to link phonetic symbols with actual spoken forms, which helped learners internalise both segmental and suprasegmental features.

Integrating technology with phonetics education was also highlighted in a systematic review by Indriyani (2023), which identified emerging digital pedagogies in phonetic instruction. This review emphasised the use of acoustic and articulatory tools, network-based learning modes, and communicative pronunciation teaching supported by digital means, reflecting a shift from traditional on-campus phonetic drills toward more interactive digital environments. Further technological advances appeared in research on automated pronunciation scoring and mobile applications. For example, Flowchase (Tits & Broisson, 2023) presented a smartphone application that provides personalised feedback on both segmental and suprasegmental pronunciation features using machine learning models. Such developments indicate a move toward adaptive and responsive pronunciation support, aligning with the need for immediate, individualised feedback in digital ELT contexts.

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Another strand of research examined blended and multimodal pronunciation learning methods. Scheffler and Baranowska (2023) investigated how engaging with English video subtitled in L1 or L2 influenced learners' recognition and production of pronunciation features, demonstrating that digital audiovisual content can enhance learners' phonetic awareness and intelligibility. This suggests that multimodal digital input can strengthen phonetic acquisition when combined with structured pronunciation tasks. Finally, Sokyrska (2023) provided a broader perspective on pronunciation as a key aspect of ELT, reviewing modern trends that include digital tools and innovative pedagogies in phonetic education. This study situates phonetic learning within larger ELT frameworks, emphasising the continued importance of pronunciation in language programs and its interaction with technology-enhanced instruction.

Digital Strategies, Learning Outcomes, and Challenges (2023)

The 2023 literature shows clearer evidence of how digital tools influence phonetic learning. The phonetic transcription app study (Fitria, 2023) reported that learners became more attentive to sound-symbol correspondence after using the app, which enhanced their pronunciation production and self-confidence. Similarly, multi-modal audiovisual tools were found to improve learners' phonological recognition and production when integrated with digital input such as subtitled videos, bridging spoken form awareness with visual cues.

Despite these positives, researchers also highlighted limitations. Indriyani's review noted that many tools still emphasise segmental features over suprasegmentals, and that teacher scaffolding and pedagogical frameworks remain crucial for learners to transfer digital practice into fluent speech. Flowchase's mobile application work pointed out challenges related to algorithm accuracy and computational complexity, which can affect the quality of personalised feedback. Additionally, broader trend analyses (Sokyrska, 2023) warned that pronunciation instruction must remain grounded in ELT pedagogical principles to avoid overreliance on technology alone.

Overall, 2023 research reflects a maturation of digital phonetics scholarship, with a movement toward interactive, learner-centred tools and a more nuanced understanding of how digital environments can support phonetic development within ELT.

Table 4.4

Summary of 2023 Studies on Digital Phonetics in ELT

Article	Digital Integration Trend	Impact on Phonetic Learning	Identified Challenges
Fitria (2023)	Phonetic transcription app	Enhanced sound-symbol mapping and pronunciation practice	**Limited scope for suprasegmentals**
Indriyani (2023)	Technology + phonetic pedagogy review	Interactive and communicative learning trends	**Need teacher guidance**
Flowchase (Tits & Broisson, 2023)	Mobile app with ML feedback	Personalised feedback on segmental and suprasegmental features	**Model complexity & accuracy**
Scheffler & Baranowska (2023)	Multimedia video input	Improved phonological awareness & production	**Context-dependent gains**
Sokyrska (2023)	ELT pronunciation trends	Broadens pronunciation focus with digital tools	**Ensuring pedagogical grounding**

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Phonetics in Digital Language Learning and ELT (2024)

The research published in 2024 shows an expansion of digital tools and innovative technologies integrated into phonetic instruction within English Language Teaching. Astuti and Citraresmana (2024) investigated the use of the AR Makr application, an augmented-reality learning tool, to enhance phonetics skills and digital literacy among secondary school EFL learners. Their qualitative findings indicate that engaging, interactive AR content supported learners' phonetic awareness and motivation, demonstrating how immersive technologies can serve phonetics instruction in digital ELT environments.

In a broader systematic perspective, Aryanti and Santosa (2024) reviewed artificial intelligence applications designed to improve EFL students' pronunciation. Their synthesis highlights how tools such as ELSA Speak and virtual assistant applications provide personalised, adaptive feedback that enhances both recognition and production of English sounds, showing a clear trend toward AI-supported phonetic learning. Technology-enhanced tools remain influential beyond AI alone. Malik et al. (2024) evaluated the effectiveness of technology-enhanced language learning tools for phonics instruction with young learners, indicating that even phonics and early sound awareness can be strengthened by digital interventions, though the direct link to advanced phonetic features such as suprasegmentals requires further study.

Another empirical study examined web-assisted instruction for phonetic learning among Spanish learners of EFL, reporting that Computer-Assisted Pronunciation Training (CAPT) tools enhanced learners' perceptual and productive phonetic capacities while also accounting for learner and instructor perceptions (García & Martínez, 2024). These findings support the notion that web-based phonetics tools can meaningfully contribute to blended pronunciation learning. Finally, research published in *English Language Teaching* (2024) highlights the importance of phonetic principles within technologically supported instructional contexts. This study found that digital tools offering real-time phonetic feedback and structured pronunciation practice were perceived by teachers and students as valuable for building learner autonomy and effectiveness in pronunciation learning (Rahman & Iqbal, 2024).

Together, these studies demonstrate that 2024 research not only integrates digital tools and AI into phonetic instruction but also reflects a broader understanding of how these technologies impact learner engagement, motivation, and phonetic competence. The growing variety of digital platforms, including AR, web-assisted instruction, and AI-enhanced feedback, highlights multiple pathways through which phonetics learning is evolving in ELT.

Learning Outcomes, Pedagogical Implications, and Limitations (2024)

Across the 2024 literature, digital interventions show positive effects on pronunciation learning outcomes. The AR Makr application contributed to improved phonetic awareness and student motivation, suggesting enhanced learner engagement when phonetics is embedded in interactive digital environments. Aryanti and Santosa (2024) emphasise that AI tools can offer personalised feedback that fosters both perception and production improvements, reinforcing the potential of adaptive learning systems in pronunciation instruction.

However, several limitations emerge. While Malik et al. (2024) demonstrate technology's effectiveness for basic phonics, its direct implications for advanced phonetic features in adult ELT contexts remain limited. The web-assisted instruction study highlights that teacher support and training remain key for maximising the benefits of digital tools, especially when learners encounter challenging phonetic contrasts. The *English Language Teaching* study further underscores that scaffolded phonetic guidance is necessary for students to fully leverage digital technologies. The 2024 research reveals that digital tools, whether AR, web-based, or AI-enhanced, continue to expand phonetics instruction in ELT, offering varied benefits while also pointing to areas requiring careful pedagogical integration and further empirical evaluation.

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Table 4. 5
Summary of 2024 Studies on Digital Phonetics in ELT

Article	Digital Integration Trend	Impact on Phonetic Learning	Identified Challenges
Astuti & Citraresmana (2024)	Augmented reality phonetics app	Increased engagement and phonetic awareness	**AR implementation complexity**
Aryanti & Santosa (2024)	AI pronunciation tools review	Personalised feedback and adaptive support	**Need clearer pedagogical frameworks**
Malik et al. (2024)	Technology-enhanced phonics tools	Improves early sound awareness	**Limited advanced phonetic focus**
(García & Martínez, 2024).	CAPT in blended learning	Enhanced perception & production	**Requires instructor mediation**
Rahman & Iqbal (2024)	Phonetic principles + digital tools	Higher autonomy & structured practice	**Need teacher guidance for effectiveness**

Phonetics in Digital Language Learning and ELT (2025)

The studies from 2025 reflect the deepening integration of AI-powered digital tools into pronunciation and phonetics instruction within English Language Teaching. Nazir, Javed, and Baig (2025) explored the implementation of AI-powered pronunciation platforms such as Speechling and ChatGPT among Pakistani ESL learners, finding that AI tools provided immediate corrective feedback, which learners perceived as enhancing fluency and confidence in spoken English.

Similarly, research by Dilshatuly (2025) showed significant improvements in pronunciation accuracy and learner confidence among school learners using speech-recognition-based AI tools compared with traditional instruction, underscoring the potential of AI when integrated with real-time feedback mechanisms. Prakash and Kausalya (2025) further confirmed these trends by demonstrating that speech-to-text AI systems provided consistent phoneme-level feedback that led to measurable gains in pronunciation accuracy, indicating that AI is becoming more effective at supporting autonomous phonetic practice.

Sarwadi's mixed-methods study adds to this picture by showing that AI-assisted pronunciation training systems not only improved pronunciation performance but also helped learners develop better intonation and stress patterns, though regional accent detection remains a challenge. Alongside these AI-centric studies, Sholahuddin, Ananta, and Khoiriyah (2025) found that a range of educational speaking technology tools (including authentic pronunciation examples and phonetic guides) significantly enhanced pronunciation performance and learners' confidence when combined with guided instruction.

Together, these 2025 studies show that digital phonetics in ELT is now characterised by advanced AI integration, real-time corrective feedback, and expanded focus on both segmental and some suprasegmental features. They also highlight the growing emphasis on learner perceptions and confidence as key outcomes of digital pronunciation learning.

Learning Outcomes, Pedagogical Implications, and Limitations (2025)

Across the 2025 studies, digital tools consistently show positive outcomes for phonetics and pronunciation learning. AI-powered feedback was associated with measurable improvements in accuracy and learner confidence, particularly when tools offered individualised, phoneme-level guidance (Prakash & Kausalya, 2025). Dilshatuly (2025) reported enhanced

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pronunciation accuracy and learner confidence with AI support, while Sarwadi (2025) noted improvements in prosodic features such as stress and intonation.

Despite these gains, limitations were also reported. Learners in Nazir et al. (2025) mentioned issues related to internet dependency and a lack of contextual explanations from AI models. Similarly, Sarwadi (2025) found challenges in accent recognition, which affected feedback accuracy for certain learner groups. Research by Sholahuddin et al. (2025) emphasised the need for teacher guidance alongside educational technology tools to ensure phonetic gains transfer effectively to real communication contexts. Overall, the 2025 literature reflects an advanced phase of digital phonetics research in ELT, where AI tools are integral to pronunciation training, but their effectiveness is maximised when integrated with pedagogical support and contextualised learning tasks.

Table 4.6

Summary of 2025 Studies on Digital Phonetics in ELT

Article	Digital Integration Trend	Impact on Phonetic Learning	Identified Challenges
Nazir, Javed & Baig (2025)	AI-powered pronunciation tools	Improved fluency & confidence	**Internet dependency & lack of contextual support**
Dilshatuly (2025)	AI speech recognition systems	Enhanced pronunciation accuracy	**Need for human-AI balance**
Prakash & Kausalya (2025)	Speech-to-text AI feedback	Significant phoneme accuracy gains	**Long-term retention data needed**
Sarwadi (2025)	AI-assisted training mixed-methods	Improved stress & intonation	**Accent detection limitations**
Sholahuddin et al. (2025)	Educational speaking technology tools	Enhanced pronunciation & confidence	**Requires integrated classroom practice**

Findings

This section presents the findings of the systematic review examining phonetics instruction in digital language learning environments in English Language Teaching (ELT) research published from 2020 to 2025. The analysis is organised around the three main research questions: (1) how phonetics instruction has been integrated into digital language learning in ELT research; (2) the effects of digital tools and technologies on learners' phonetic and pronunciation development; and (3) the key challenges and research gaps identified in the literature.

Integration of Phonetics Instruction in Digital ELT (2020–2025)

Across the six years of reviewed research, phonetics instruction increasingly shifted from traditional classroom methods to more digitally mediated approaches. In the early period (2020–2021), integration was primarily exploratory, with researchers examining how mobile-assisted language learning (MALL) and computer-assisted pronunciation training (CAPT) tools could supplement conventional phonetic drills. Articles from 2020 and 2021 focused on digital tools such as pronunciation apps and structured CAPT systems to support articulation and repetitive practice (e.g., mobile apps providing audio models and feedback). By 2022 and 2023, studies began reporting more sophisticated uses of digital tools, including artificial intelligence (AI)-based systems offering personalised feedback and multi-aspect assessment

models that extend beyond simple segmental correction to incorporate broader phonetic awareness.

Systematic reviews and empirical studies indicate that digital integration has become more intentional and pedagogically framed. Indriyani's (2023) review highlighted the use of acoustic and articulatory technology and network-based learning modes to enhance phonetic instruction, showing that technology is no longer an add-on but part of structured learning practices. Similarly, 2024 research shows the inclusion of augmented reality (AR) applications and AI-supported platforms that provide immersive phonetic practice, signalling a maturation of digital approaches. By 2025, AI-driven tools such as conversational agents and speech-to-text systems will be documented as central components of pronunciation instruction, underscoring a substantial integration of advanced digital technologies into ELT phonetic pedagogy.

Collectively, the literature reveals a clear trajectory: phonetics instruction has moved from basic digital supplementation toward integrated, adaptive, and interactive technology-mediated learning environments in ELT research over the past six years. These tools are increasingly embedded within pedagogical frameworks rather than being treated as peripheral resources.

Effects of Digital Tools on Learners' Phonetic and Pronunciation Development

The second research question focused on the impact of digital tools and technologies on learners' pronunciation outcomes. Across reviewed studies, evidence consistently shows that digital technologies positively influence pronunciation development in multiple dimensions. Mobile devices and pronunciation apps helped learners improve segmental accuracy (e.g., vowels and consonants) and increased practice time outside the classroom, contributing to greater confidence and autonomy in pronunciation learning. For instance, mobile pronunciation applications enhanced learners' phonetic awareness and allowed for repeated self-practice, which is essential for acquiring difficult L2 sounds.

More advanced technologies, such as AI-powered feedback systems and speech-to-text applications, show promising effects on both perception and production of English sounds. These tools provide immediate, individualised corrective feedback that supports deeper phonetic learning and helps learners identify subtle errors more effectively than traditional methods. Studies involving AI instruction reported measurable gains in pronunciation accuracy, and learners often maintained these improvements over time. This indicates an important advantage of digital tools: adaptive feedback and personalised learning paths that are difficult to achieve in face-to-face settings alone. Systematic literature reviews specifically examining mobile-assisted pronunciation training further confirm that overall, mobile and CAPT technologies yield positive outcomes for pronunciation acquisition and learner attitudes toward practice. Even beyond segmental features, some AI systems have aided learners in improving suprasegmental features such as stress and intonation, though to a lesser extent. Multimodal integration, such as video or AR-based tools, also contributed to improved phonological awareness by engaging learners' visual, auditory, and interactive capacities concurrently.

Key Challenges and Research Gaps in Digital Phonetics Instruction

Despite the documented benefits of digital technologies, several challenges persist in ELT research on phonetics. One major issue is unequal access to technology and digital resources. Many studies note that reliable internet access, suitable devices, and learners' digital literacy influence the effectiveness of technology-mediated phonetic instruction, particularly in low-resource contexts.

Another recurring challenge is the limited transfer of gains from controlled digital practice to spontaneous speech production. While many tools improve isolated sound production and

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discrimination, learners often struggle to apply these gains in natural communicative contexts, suggesting a gap between controlled practice and fluent speech. Feedback quality is also a concern. Although AI and speech recognition systems provide immediate corrective feedback, their accuracy can vary, especially with non-native accents or speakers with diverse phonetic backgrounds, leading to potential misguidance. Moreover, many tools emphasise segmental features (individual sounds) more than suprasegmentals (stress, rhythm, intonation), even though prosody is essential for natural intelligibility.

Pedagogical challenges include the need for teacher readiness, training, and integration strategies that combine digital tools with sound instructional design. Some studies highlight that teachers often feel underprepared to effectively integrate these technologies and that training is necessary to avoid superficial use of digital tools. Finally, research gaps remain in longitudinal studies that assess sustained learning outcomes over time and at more advanced proficiency levels. More research is also needed on the long-term impact of phonetic technologies on real-world communication and learner retention.

Figure 5.1

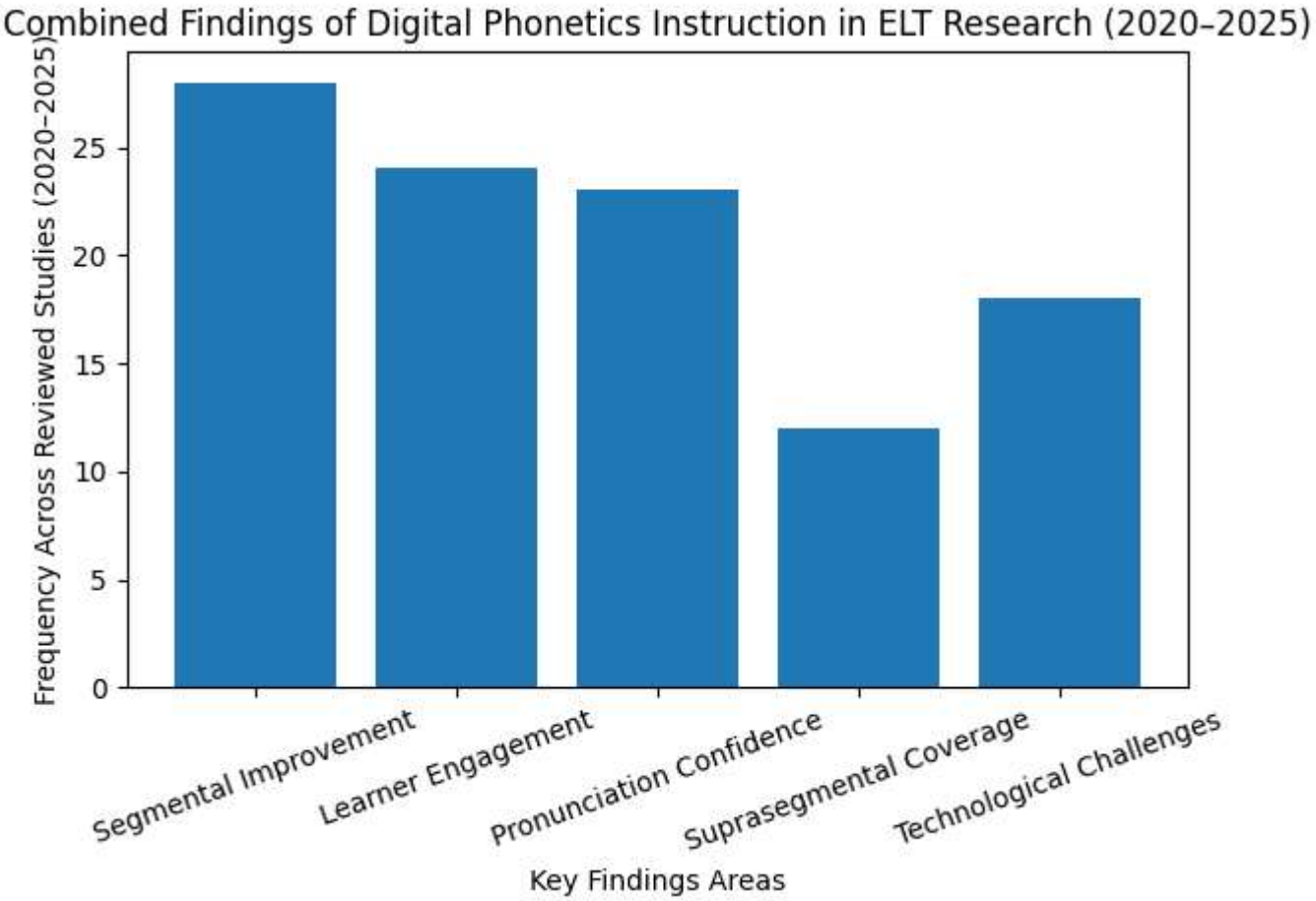

Figure 5.1 summarises the dominant trends and challenges identified across ELT studies published between 2020 and 2025, highlighting a strong focus on segmental pronunciation development alongside ongoing limitations in suprasegmental instruction.

Conclusion and Future Recommendations

This study concludes that phonetics instruction has become an increasingly integral component of digital language learning within ELT research published between 2020 and 2025. The reviewed studies consistently demonstrate that digital tools such as mobile applications,

computer-assisted pronunciation training systems, and AI-based platforms have been effectively integrated to support the teaching of phonetic features, particularly segmental aspects of pronunciation. These tools have enabled greater learner autonomy, increased practice opportunities, and immediate feedback, which are often difficult to achieve in traditional classroom settings. Overall, the findings confirm that digital environments provide a supportive and flexible space for enhancing learners' phonetic awareness and pronunciation accuracy.

In terms of learning outcomes, the analysis reveals that digital phonetics instruction has a generally positive impact on learners' pronunciation development, motivation, and confidence. Many studies report measurable improvements in intelligibility and accuracy, especially when digital tools are combined with structured pedagogical guidance. However, the findings also indicate that most research has focused on short-term interventions and controlled learning contexts. Suprasegmental features such as stress, rhythm, and intonation remain underexplored, and learners often face difficulties transferring digitally practised phonetic skills to spontaneous spoken communication. These limitations suggest that digital tools alone are not sufficient and must be meaningfully integrated into broader instructional frameworks.

Based on these conclusions, future research should prioritise longitudinal studies to examine the sustained effects of digital phonetics instruction over time. Greater attention is also needed for suprasegmental instruction and for diverse learning contexts, including primary education and teacher training programs. Researchers should explore hybrid instructional models that combine digital tools with classroom interaction to support the transfer of phonetic skills to real-life communication. Additionally, future studies should critically evaluate the pedagogical design of pronunciation technologies to ensure they align with established phonetic and second language acquisition principles. Addressing these areas will contribute to a more balanced and comprehensive understanding of digital phonetics instruction in ELT.

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