

TEACHERS' PEDAGOGICAL READINESS FOR BRAIN-BASED AND TECHNOLOGY-ENHANCED PRONUNCIATION INSTRUCTION IN PRIMARY EFL CLASSROOMS

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ABSTRACT

Teachers' pedagogical readiness is essential for implementing innovative pronunciation instruction in primary English as a Foreign Language (EFL) classrooms. However, limited research has examined teachers' readiness to integrate Brain-Based Learning (BBL) with technology-enhanced pronunciation instruction. This study investigated primary EFL teachers' pedagogical readiness using an explanatory sequential mixed-methods design. Quantitative data were collected through a structured questionnaire administered to 34 primary EFL teachers selected through purposive sampling and analyzed using descriptive statistics. Semi-structured interviews were subsequently conducted with selected participants and analyzed using thematic analysis supported by Atlas.ti 25. The findings indicated a high overall level of pedagogical readiness ($M = 4.22$). Among the five dimensions, Brain-Based Learning Readiness obtained the highest mean score, whereas Instructional Planning Readiness received the lowest, although all dimensions were categorized as high. The interviews identified learner-centered instructional planning, interactive brain-based learning activities, technology integration, and professional support as key facilitating factors. Major barriers included limited instructional time, differences in students' learning abilities, inadequate technological facilities, unstable internet connectivity, and limited professional development. Overall, the findings suggest that strengthening teachers' pedagogical readiness requires continuous professional development, improved technological infrastructure, and practical instructional models integrating Brain-Based Learning with technology-enhanced pronunciation instruction.

Keywords: *Brain-Based Learning; pedagogical readiness; primary EFL; pronunciation instruction; technology integration.*

INTRODUCTION

Pronunciation instruction remains a persistent challenge in English as a Foreign Language (EFL) classrooms, particularly at the primary school level where learners often have limited exposure to authentic spoken English. Although early language learning is widely recognized as a critical period for developing phonological awareness, speech intelligibility, and oral communication skills, pronunciation frequently receives less pedagogical attention compared to grammar and vocabulary instruction (Kim, 2023); (Sesma et al., 2022). This imbalance may hinder learners' communicative competence

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because intelligible pronunciation is a fundamental component of effective spoken interaction and successful communication in English (Rogerson-Revell, 2011); (Hu et al., 2025). In many EFL contexts, pronunciation teaching is still constrained by traditional drilling techniques, limited instructional resources, and insufficient teacher preparation (Mirzayev, 2024).

Recent developments in neuroscience and language acquisition research have emphasized the importance of early pronunciation exposure in foreign language learning. Young learners possess high levels of neuroplasticity, enabling them to acquire phonological patterns more naturally when learning experiences are engaging, meaningful, and emotionally supportive (Bondarenko, 2025). Research on brain development and language learning suggests that children learn more effectively when instructional practices align with how the brain naturally processes, stores, and retrieves information (Pradeep et al., 2024); (Ayubi et al., 2024); (Alshokhada et al., 2026). These findings have contributed to the growing interest in brain-based learning (BBL) as a pedagogical approach in language education.

The rapid expansion of digital transformation in education has also accelerated the emergence of Education 5.0 and Industry 5.0 paradigms, which emphasize the integration of advanced technologies with human-centered and socially responsive learning practices (Akman & Erdirencelebi, 2024). Unlike previous educational paradigms that primarily focused on technological efficiency and automation, Education 5.0 highlights the importance of balancing technological innovation with learners' cognitive, emotional, social, and creative development (Agarwal et al., 2025). In language education, this transformation has encouraged the growing use of artificial intelligence (AI), adaptive learning systems, speech recognition technologies, immersive digital environments, and personalized learning platforms that can support more interactive and individualized learning experiences. In pronunciation instruction, AI-powered tools such as Automatic Speech Recognition (ASR), intelligent pronunciation feedback systems, and speech analysis applications provide learners with immediate corrective feedback, repeated pronunciation practice, and authentic language exposure that may not always be available in traditional classroom settings (Agustina et al., 2022); (Rogerson, 2021). However, the successful integration of such technologies requires future-ready teachers who are capable of adapting to rapidly evolving educational environments while maintaining pedagogical sensitivity toward learners' developmental and emotional needs. Within the context of Education 5.0, teachers are no longer expected to function merely as transmitters of knowledge, but also as facilitators, designers of meaningful learning experiences, critical users of educational technologies, and promoters of human-centered learning environments (Sharma, 2026). Consequently, teachers' pedagogical readiness becomes increasingly important in ensuring that technology-enhanced pronunciation instruction remains developmentally appropriate, emotionally supportive, communicative, and aligned with the cognitive characteristics of young EFL learners.

The integration of brain-based learning principles and educational technology offers considerable potential for improving pronunciation instruction in primary EFL classrooms. However, the successful implementation of these approaches depends largely on teachers' pedagogical readiness. Teachers are expected not only to understand pronunciation pedagogy but also to design meaningful learning experiences, integrate appropriate technologies, and respond to the developmental needs of young learners. Despite increasing interest in brain-based pedagogy and technology-enhanced language learning, previous studies have mainly examined technology integration or teacher



readiness separately. Limited attention has been given to teachers' pedagogical readiness for implementing both brain-based and technology-enhanced pronunciation instruction in primary EFL classrooms. Furthermore, contextual factors such as limited professional training, technological resources, and institutional support may influence teachers' readiness to adopt innovative instructional practices.

Therefore, this study aims to investigate primary EFL teachers' pedagogical readiness for implementing brain-based and technology-enhanced pronunciation instruction. Specifically, the study seeks to: (1) identify the level of teachers' pedagogical readiness, (2) determine the dimensions of readiness perceived as strongest and weakest, and (3) explore factors that facilitate or hinder the implementation of brain-based and technology-enhanced pronunciation instruction in primary EFL classrooms.

METHOD

This study employed an explanatory sequential mixed-methods design to investigate the pedagogical readiness of primary EFL teachers for implementing brain-based and technology-enhanced pronunciation instruction (W. Wang, 2023). The study was conducted in two consecutive phases. In the quantitative phase, data were collected through a structured questionnaire administered to 34 primary school English teachers selected through purposive sampling. The participants were actively teaching English at the primary school level and had experience using technology in classroom instruction. Given the exploratory nature of this study, the sample was intended to provide preliminary insights into teachers' pedagogical readiness rather than statistical generalization.

The questionnaire measured teachers' pedagogical readiness across five dimensions: instructional planning readiness, instructional implementation readiness, assessment and feedback readiness, brain-based learning readiness, and technology integration readiness. Quantitative data were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations, to identify teachers' readiness levels and determine the dimensions perceived as strongest and weakest.

In the qualitative phase, participants representing high, moderate, and low readiness levels, as identified from the survey results, were selected for semi-structured interviews. The interviews aimed to explore teachers' perceptions, experiences, supporting factors, and challenges related to the implementation of brain-based and technology-enhanced pronunciation instruction in primary EFL classrooms. The interview data were analyzed using thematic analysis following (Braun & Clarke (2006) framework.

The quantitative and qualitative findings were integrated during the interpretation stage to provide a comprehensive understanding of teachers' pedagogical readiness and the contextual factors influencing the implementation of brain-based and technology-enhanced pronunciation instruction.

RESULTS AND DISCUSSION

This section presents and discusses the findings of the study based on the three research questions. Following the explanatory sequential mixed-methods design, the quantitative findings are presented first to describe the overall level and dimensions of

teachers' pedagogical readiness for implementing brain-based and technology-enhanced pronunciation instruction. The qualitative findings are then presented to explain and enrich the quantitative results by exploring teachers' perceptions, experiences, and the contextual factors that facilitate or hinder the implementation of these instructional approaches. The integration of both sets of findings provides a comprehensive understanding of primary EFL teachers' pedagogical readiness in contemporary pronunciation instruction.

Teachers' Pedagogical Readiness

To address the first research question regarding the overall level of teachers' pedagogical readiness, descriptive statistics were calculated for each readiness dimension and the overall readiness score. The results are presented in Table 1.

Table 1 Teachers' Pedagogical Readiness for Implementing Brain-Based and Technology-Enhanced Pronunciation Instruction

Dimension	Mean (M)	Readiness Level
Instructional Planning Readiness	4.01	High
Instructional Implementation Readiness	4.12	High
Assessment and Feedback Readiness	4.15	High
Brain-Based Learning Readiness	4.46	High
Technology Integration Readiness	4.31	High
Overall Readiness	4.21	High

Note. Readiness levels were interpreted as follows: 1.00–2.33 = Low, 2.34–3.66 = Moderate, and 3.67–5.00 = High.

Table 1 presents the overall level of teachers' pedagogical readiness for implementing brain-based and technology-enhanced pronunciation instruction. The findings indicate that the participants demonstrated a high level of pedagogical readiness, with an overall mean score of 4.21. This result suggests that the teachers generally perceived themselves as well prepared to integrate brain-based learning principles and educational technology into pronunciation instruction for young EFL learners.

Among the five dimensions, Brain-Based Learning Readiness obtained the highest mean score ($M = 4.46$), followed by Technology Integration Readiness ($M = 4.31$), Assessment and Feedback Readiness ($M = 4.15$), Instructional Implementation Readiness ($M = 4.12$), and Instructional Planning Readiness ($M = 4.01$). Although all dimensions were classified as high, the findings suggest that teachers expressed greater confidence in understanding and applying brain-based learning principles than in systematically planning pronunciation instruction. The comparatively lower mean for instructional planning indicates that lesson design remains the area with the greatest room for improvement.

The consistently high scores across all dimensions indicate that the participating teachers possess a strong foundation for implementing innovative pronunciation instruction. In particular, their high readiness in brain-based learning and technology integration suggests positive attitudes toward learner-centered pedagogy and the use of digital tools in English language teaching. These findings are consistent with previous studies reporting that teachers are becoming increasingly prepared to adopt innovative instructional approaches and educational technologies in response to evolving educational demands (Jing et al., 2024); (Almusawi & Durugbo, 2024). Nevertheless, the relatively lower score for instructional planning readiness implies that teachers may still benefit from targeted professional development focusing on designing pronunciation



lessons that effectively integrate brain-based learning principles with technology-enhanced instructional strategies. Strengthening teachers' competencies in instructional design may further improve the quality and sustainability of pronunciation instruction for young EFL learners.

Strongest and Weakest Dimensions of Readiness

To answer the second research question regarding the dimensions of teachers' pedagogical readiness, the mean scores of each readiness dimension were ranked from the highest to the lowest. The results are presented in Table 2.

Table 2 Ranking of Teachers' Pedagogical Readiness Dimensions

Rank	Dimensions	Mean
1	Brain-Based Learning Readiness	4.46
2	Technology Integration Readiness	4.31
3	Assessment and Feedback Readiness	4.18
4	Instructional Implementation Readiness	4.08
5	Instructional Planning Readiness	4.01

As shown in Table 2, all five dimensions of teachers' pedagogical readiness were classified as high, with mean scores ranging from 4.01 to 4.46. Among these dimensions, Brain-Based Learning Readiness obtained the highest mean score ($M = 4.46$), indicating that the participating teachers reported the highest level of readiness in understanding and applying learner-centered instructional approaches grounded in brain-based learning principles. Specifically, the findings suggest that teachers recognized the importance of creating meaningful, emotionally supportive, and engaging learning environments that accommodate young learners' cognitive characteristics. This result aligns with Brain-Based Learning theory, which emphasizes that learning becomes more effective when instruction reflects the brain's natural learning processes and promotes active, meaningful experiences (Jensen, 2008).

The second-highest mean score was found for Technology Integration Readiness ($M = 4.31$), indicating that teachers generally perceived themselves as well prepared to utilize digital technologies to support pronunciation instruction. This finding reflects teachers' positive perceptions of educational technology and their readiness to integrate digital resources into classroom practices. It also supports previous research showing that teachers are increasingly willing to adopt technology-enhanced language learning when they possess sufficient technological knowledge and experience (Almusawi & Durugbo, 2024), (Wang et al., 2023).

Assessment and Feedback Readiness ranked third with a mean score of 4.18, suggesting that the participants perceived themselves as capable of monitoring students' pronunciation development and providing constructive feedback. The relatively high score indicates that teachers felt prepared to employ various assessment strategies, including technology-assisted feedback, to facilitate learners' pronunciation improvement (Rafi, 2026).

Instructional Implementation Readiness ranked fourth ($M = 4.08$). Although still categorized as high, this result suggests that teachers were slightly less confident in

implementing pronunciation instruction than in assessing students or integrating technology. The finding implies that translating pedagogical knowledge into effective classroom practices may remain a challenging aspect of pronunciation teaching, particularly when instruction requires the simultaneous application of learner-centered, brain-based, and technology-supported strategies.

Among all dimensions, Instructional Planning Readiness received the lowest mean score ($M = 4.01$), although it remained within the high readiness category. This finding indicates that lesson planning represents the dimension with the greatest potential for improvement. Designing pronunciation lessons that systematically integrate brain-based learning principles, technology-enhanced instructional strategies, learning objectives, classroom activities, and assessment procedures requires sophisticated pedagogical and instructional design competencies (Al-Awaid & Awdh Hussain, 2025). Consequently, teachers may still benefit from professional development that specifically focuses on planning integrated pronunciation instruction (Pennington, 2021).

The ranking demonstrates that the participating teachers reported consistently high levels of pedagogical readiness across all dimensions. Nevertheless, the pattern of findings indicates that teachers perceived themselves as more prepared in understanding brain-based learning principles and integrating educational technology than in planning and implementing pronunciation instruction. This suggests that future professional development initiatives should move beyond introducing innovative pedagogical concepts and instead emphasize how teachers can transform these concepts into coherent instructional plans and classroom practices (Ghamrawi et al., 2024). Furthermore, the relatively high score for Technology Integration Readiness contrasts with earlier studies identifying technology as a major obstacle in language instruction. In the present study, technology itself does not appear to constitute the primary challenge (Hendrawan et al., 2024). Rather, the findings suggest that the more pressing issue lies in strengthening teachers' instructional planning and implementation skills so that brain-based learning principles and educational technology can be integrated into well-structured pronunciation lessons (Keereesuwanket et al., 2025).

Factors Facilitating Teachers' Readiness

To further explain the quantitative findings, semi-structured interviews were conducted with selected participants representing different readiness levels. The preliminary thematic analysis revealed four recurring themes that facilitated teachers' pedagogical readiness for implementing brain-based and technology-enhanced pronunciation instruction. The themes are presented in Table 3.

Table 3 Themes Emerging from the Interview Analysis

Theme	Representative Evidence
Learner-Centered Instructional Planning	Teachers planned pronunciation lessons based on students' age, learning abilities, and familiar vocabulary to ensure that learning activities were appropriate for young learners.
Interactive and Brain-Based Learning Activities	Teachers frequently used songs, games, repetition, reading aloud, and enjoyable classroom activities to encourage active participation and facilitate pronunciation learning.
Technology as a Facilitator of Pronunciation Instruction	Teachers perceived videos, YouTube, and audio recordings as useful resources for providing accurate pronunciation models and increasing students' learning motivation.



Professional Support for Instructional Improvement	Teachers emphasized the importance of professional training, adequate technological facilities, and appropriate instructional models to strengthen pronunciation teaching.
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Figure 1 illustrates the relationships among the four themes identified through the thematic analysis. The network visualization generated using Atlas.ti demonstrates how learner-centered instructional planning, interactive brain-based learning activities, technology integration, and professional support collectively contribute to teachers' pedagogical readiness.

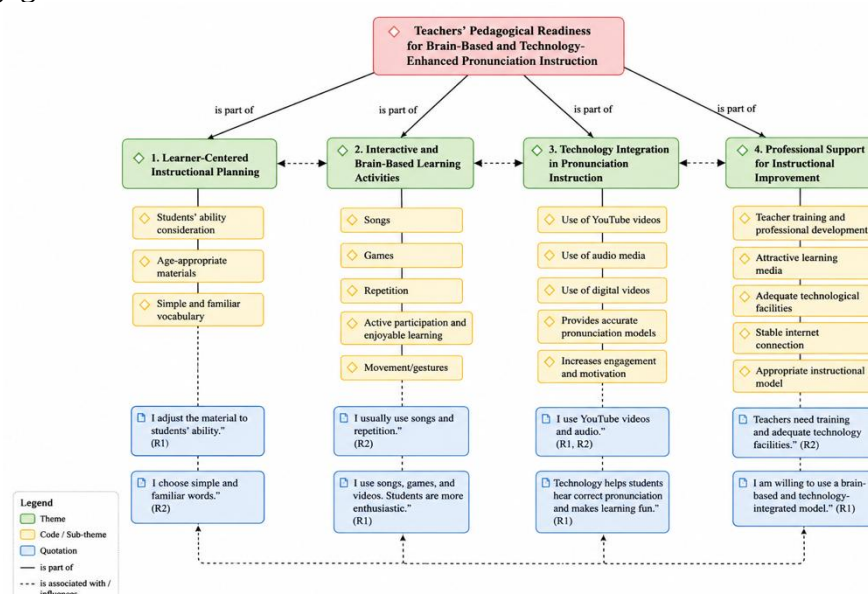


Figure 1 Network view of factors facilitating teachers' pedagogical readiness

The first facilitating theme, learner-centered instructional planning, indicates that teachers considered students' developmental characteristics, learning abilities, and familiarity with vocabulary when designing pronunciation activities. Rather than introducing complex linguistic content, participants preferred to begin with simple and familiar words before gradually increasing the level of difficulty. This finding suggests that teachers were aware of the importance of aligning instructional planning with young learners' cognitive development and learning readiness.

The second theme highlights the importance of interactive and brain-based learning activities. Across the interviews, participants consistently described the use of songs, games, repetition, reading aloud, movement, and enjoyable classroom activities as effective strategies for teaching pronunciation. Although the participants were not initially familiar with the formal concept of Brain-Based Learning, many of their classroom practices reflected its core principles, including active participation, meaningful repetition, emotional engagement, and multisensory learning experiences. These findings help explain why Brain-Based Learning Readiness obtained the highest mean score in the quantitative phase.

The third theme identifies technology as a facilitator of pronunciation instruction. Participants reported using digital resources such as YouTube videos, audio recordings,

and short instructional videos to provide students with accurate pronunciation models and increase classroom engagement. Teachers believed that technology enabled students to hear authentic pronunciation while making learning more enjoyable and motivating. However, they also acknowledged that unstable internet connections and limited technological facilities occasionally constrained classroom implementation. Professional support for instructional improvement emerged as another important facilitating factor. Participants expressed a willingness to adopt innovative instructional models that integrate Brain-Based Learning principles and educational technology. They also emphasized the need for professional development opportunities, attractive instructional media, and adequate technological infrastructure to enhance their pedagogical readiness. These findings suggest that teachers' readiness is influenced not only by individual competence but also by institutional support and continuous professional learning opportunities.

Factors Hindering Teachers' Readiness

To further explain the challenges underlying teachers' pedagogical readiness, the interview data were analysed using thematic analysis. Five recurring themes emerged as factors that hindered teachers' readiness to implement brain-based and technology-enhanced pronunciation instruction. These themes include limited instructional time, differences in students' learning abilities, limited technological facilities, unstable internet connectivity, and limited professional development.

Figure 3 illustrates the relationships among these themes based on the coding process conducted in Atlas.ti. The network visualization demonstrates that teachers' readiness was influenced by interconnected contextual challenges rather than by a single factor. The findings indicate that limited instructional time, diverse student abilities, technological constraints, and insufficient professional support collectively affected teachers' implementation of brain-based and technology-enhanced pronunciation instruction.

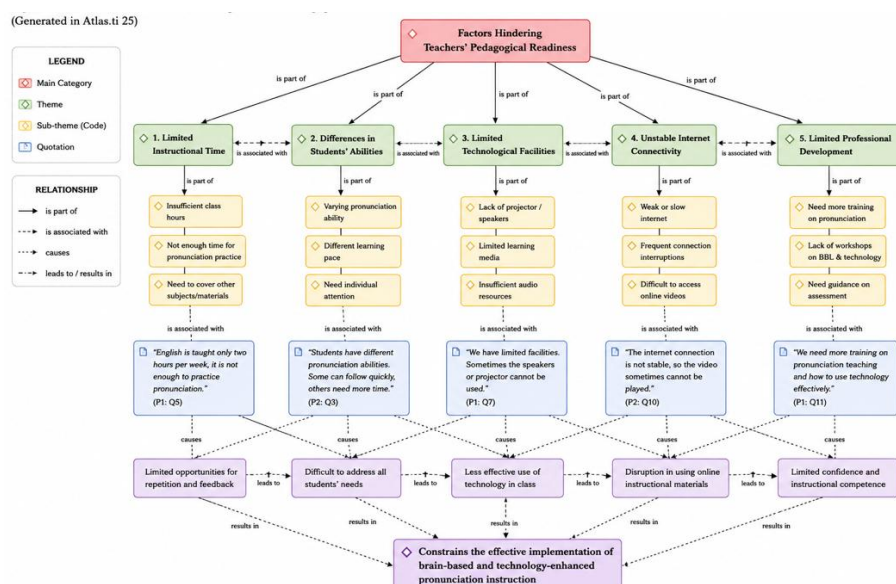


Figure 2 Network View of Factors Hindering Teachers' Pedagogical Readiness Generated Using Atlas.ti 25



As illustrated in Figure 3, the identified barriers are closely interconnected and collectively shape teachers' pedagogical readiness. To provide a clearer summary of these themes and their supporting evidence, the interview findings are presented in Table 4.

Table 4 Factors Hindering Teachers' Pedagogical Readiness

Theme	Representative Evidence
Limited instructional time	Teachers reported that the limited duration of English lessons restricted opportunities for repeated pronunciation practice and individual feedback.
Differences in Students' Learning Abilities	Teachers experienced difficulties in accommodating students with varying pronunciation abilities within the same classroom.
Limited technological facilities	The lack of projectors, speakers, and other instructional media limited the implementation of technology-enhanced pronunciation instruction.
Unstable internet connection	Poor internet access frequently interrupted the use of YouTube videos and other online pronunciation resources.
Limited professional development	Teachers expressed the need for more training and practical guidance on pronunciation pedagogy, Brain-Based Learning, and technology integration.

The first theme, limited instructional time, emerged as one of the most frequently mentioned barriers. Participants explained that English instruction is allocated only a limited number of hours each week, making it difficult to provide sufficient pronunciation practice, repeated exposure, and individualized feedback. As pronunciation learning requires continuous practice and reinforcement, teachers felt constrained in implementing effective instructional activities.

Another challenge concerned the differences in students' learning abilities. Participants reported that students progressed at different rates, requiring differentiated instructional support. While some students were able to imitate and produce English sounds accurately after several repetitions, others required considerably more practice and individual guidance. This diversity made it difficult for teachers to ensure that all students achieved similar levels of pronunciation proficiency within the available instructional time.

The third theme was limited technological facilities and unstable internet connectivity. Although teachers acknowledged the benefits of using YouTube videos, audio recordings, and other digital resources to model accurate pronunciation, they reported that inadequate classroom facilities and unstable internet connections often limited the effective use of these technologies during instruction.

Finally, limited professional development was identified as another factor hindering teachers' readiness. Participants emphasized the need for training, practical teaching resources, and institutional support to strengthen their knowledge of pronunciation pedagogy and the integration of Brain-Based Learning with educational technology.

These findings suggest that improving teachers' readiness requires not only individual commitment but also sustained professional learning opportunities and supportive school environments.

Integrated Discussion

The integration of the quantitative and qualitative findings provides a more comprehensive understanding of teachers' pedagogical readiness for implementing brain-based and technology-enhanced pronunciation instruction in primary EFL classrooms. The quantitative results revealed that the participating teachers demonstrated a high overall level of pedagogical readiness ($M = 4.22$), with all five readiness dimensions categorized as high. Among these dimensions, Brain-Based Learning Readiness obtained the highest mean score, followed by Technology Integration Readiness, whereas Instructional Planning Readiness received the lowest mean score.

The qualitative findings help explain these quantitative results. Teachers consistently described the use of learner-centered instructional strategies, including songs, games, repetition, storytelling, movement, and enjoyable classroom activities, which closely reflect the principles of Brain-Based Learning. Although several participants were initially unfamiliar with the formal concept of Brain-Based Learning, they had already implemented many of its core principles intuitively through engaging and multisensory instructional practices. This finding explains why Brain-Based Learning Readiness emerged as the strongest dimension in the quantitative phase.

Similarly, the relatively high level of Technology Integration Readiness was supported by teachers' experiences of using YouTube videos, audio recordings, and other digital resources to model accurate pronunciation and increase students' learning engagement. However, the interviews also revealed that teachers' readiness to integrate technology was frequently constrained by contextual factors such as limited technological facilities and unstable internet connectivity. These findings suggest that high perceived readiness does not necessarily guarantee successful classroom implementation when adequate institutional support is unavailable.

The interviews also provide insight into why Instructional Planning Readiness obtained the lowest mean score among the five dimensions. Teachers explained that limited instructional time, differences in students' learning abilities, and curriculum demands made it difficult to design systematic pronunciation lessons that effectively integrated brain-based learning principles with technology-enhanced instructional strategies. Consequently, although teachers expressed positive attitudes toward innovative pronunciation instruction, they still encountered practical challenges in translating these ideas into comprehensive lesson planning.

Overall, the integration of both data sets indicates that teachers' pedagogical readiness is influenced by the interaction between individual readiness and contextual support. At the individual level, teachers demonstrated positive beliefs, instructional competence, and a willingness to adopt innovative pedagogical approaches. At the contextual level, however, their readiness was shaped by factors such as instructional time, technological infrastructure, professional development opportunities, and institutional support. These findings suggest that strengthening teachers' pedagogical readiness requires not only improving teachers' knowledge and instructional skills but also creating supportive school environments that facilitate the effective implementation of brain-based and technology-enhanced pronunciation instruction.



CONCLUSION

This study investigated primary EFL teachers' pedagogical readiness for implementing brain-based and technology-enhanced pronunciation instruction using an explanatory sequential mixed-methods design. The quantitative findings revealed that the participating teachers demonstrated a high overall level of pedagogical readiness, with Brain-Based Learning Readiness emerging as the strongest dimension, followed by Technology Integration Readiness. Although all readiness dimensions were categorized as high, Instructional Planning Readiness received the lowest mean score, indicating that teachers require greater support in systematically designing pronunciation lessons that integrate brain-based learning principles and educational technology.

The qualitative findings further explained these results by identifying several factors that facilitated and hindered teachers' pedagogical readiness. Teachers' readiness was supported by learner-centered instructional planning, interactive brain-based learning activities, the use of digital technologies, and positive attitudes toward professional development. At the same time, readiness was constrained by limited instructional time, differences in students' learning abilities, inadequate technological facilities, unstable internet connectivity, and limited professional development opportunities. These findings demonstrate that teachers' readiness is influenced not only by their individual pedagogical competence but also by the broader instructional and institutional context.

This study provides preliminary evidence that primary EFL teachers are generally prepared to adopt innovative approaches to pronunciation instruction. However, strengthening teachers' readiness requires continuous professional development, adequate technological infrastructure, and practical instructional models that integrate Brain-Based Learning principles with technology-enhanced pronunciation teaching. Such support is essential to enable teachers to translate their readiness into effective classroom practices that promote young learners' pronunciation development.

Given the exploratory nature of this study and the relatively small number of participants, the findings should be interpreted with caution and are not intended for statistical generalization. Future studies are encouraged to involve larger and more diverse samples from different educational contexts and to examine the effectiveness of specific brain-based and technology-enhanced pronunciation models on students' pronunciation achievement.

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