



TECHNOLOGICAL SCAFFOLDING IN ELEMENTARY BILINGUAL ENGLISH INSTRUCTION: A MIXED-METHODS APPROACH

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Abstract: *This research examines the incorporation of technological support in elementary bilingual education to tackle the challenges of learning a second language in today's digital world. Employing a qualitative literature review approach, the study explores how digital resources—including interactive multimedia, Augmented Reality, and automated feedback systems convert conventional instructional aid into a shared mediation network. The results reveal that technology acts as an “enhancing scaffold,” which lessens cognitive strain and promotes connections across languages through various modes of representation. Additionally, the research underscores that effective digital scaffolding necessitates a “gradual release of responsibility” to facilitate students’ transition from reliance on technology to independence in language use. The findings stress that the effectiveness of bilingual programs relies not only on the utilization of technology but also on intentional pedagogical strategies that harmonize human engagement with digital support.*

Keywords: *Technological Scaffolding, Bilingual Education, Multimodal Learning, Elementary School, Digital Literacy.*

INTRODUCTION

The development of information and communication technology has brought significant changes in the field of education, including language learning. In the era of globalization, the ability to master more than one language has become a very important skill because it can expand access to information as well as enhance academic and professional opportunities. According to research conducted by Dinda et al. (2025), bilingual teaching in elementary schools in Indonesia is increasingly important as an effort to prepare students to face global demands. The ability to speak more than one language not only increases an individual's access to broader information sources but also opens greater opportunities in the academic and professional world.

In the context of bilingual learning, technology provides broader opportunities for students to access authentic learning resources, practice language skills independently, and increase exposure to both languages being learned. However, the implementation of bilingual learning still faces various challenges, such as limited practice time, a lack of supportive language environments, and differences in students' language proficiency levels. In addition, limitations in resources and teacher competence also become obstacles in the optimal implementation of bilingual learning. In this context, the utilization of educational technology can become a solution to improve the quality of bilingual learning. Technology allows the presentation of materials to be more interactive, flexible, and engaging. The use of digital devices and learning applications such as Kahoot and Quizizz has



been proven capable of increasing motivation, engagement, and enriching students' learning resources (Artini asih & Wedayanthi, 2024).

In addition, the use of technology in bilingual learning has been proven to enhance student engagement and learning motivation. Digital media, such as learning applications, interactive videos, and online platforms, allow students to gain a more engaging learning experience and provide opportunities to practice using the second language more intensively. This is in line with findings that the use of technology-based media can improve student comprehension, reduce cognitive load, and strengthen cross-language connections in bilingual learning (Nathania et al., 2025). The development of multimedia technology, such as Augmented Reality-based applications, can also create a more contextual and enjoyable learning experience, thereby helping students understand the material more effectively (Rahayu et al., 2024).

In addition to increasing students' motivation and engagement, technology also plays a role in creating a more communicative and collaborative learning environment. Online learning platforms, digital communication applications, and internet-based media allow students to interact using the target language in various authentic contexts. This digital learning environment can expand opportunities for language practice that were previously limited to classroom learning time. Continuous interaction through technology helps students develop communicative competence more optimally and boosts confidence in using a second language (Dinda et al., 2025).

On the other hand, the utilization of technology in bilingual learning also encourages student-centered learning. Technology allows learners to study at their own pace and learning style through multimedia sources, such as audio, video, and interactive simulations. The use of diverse digital media can help students understand language concepts more contextually and improve learning retention. Research shows that the integration of multimedia technology in language learning can increase learning effectiveness and help students understand the material more deeply (Rahayu et al., 2024; Nathania et al., 2025).

Nevertheless, the use of technology in bilingual learning has not yet been utilized optimally and is often limited to the use of media as a learning aid. Studies that specifically discuss the role of technology in supporting bilingual learning comprehensively are still limited. Therefore, this research aims to examine how technology can support language learning in a bilingual context and its impact on improving students' language abilities. The contribution of this study lies in providing an empirically grounded model of technology integration in bilingual classrooms that goes beyond the use of technology as mere instructional media, positioning it instead as a pedagogical tool that systematically supports both languages and enhances students' receptive and productive skills.

METHODS

This research uses a qualitative approach using a literature study method (library research). The literature study method is a research technique conducted by collecting, reviewing, and analyzing various written sources relevant to the research topic. Data sources used in this study include scientific journal articles, books, research reports, and other academic publications related



to the use of technology in language learning and the implementation of bilingual education (Nathania et al., 2025).

The literature study approach was chosen because it allows researchers to gain a comprehensive understanding of the development of concepts, strategies, and best practices in technology-based bilingual learning. Through this method, researchers do not conduct direct field data collection but instead focus on in-depth analysis of previous research findings. This aligns with the characteristics of literature research, which emphasizes the process of synthesis, critical evaluation, and the development of new understandings based on available scientific sources.

The research procedure was conducted through several stages. The first stage was the identification and collection of literature sources relevant to the research topic, both from national and international journals discussing bilingual learning and the use of educational technology. The second stage was the selection of literature based on the criteria of relevance, novelty, and credibility of the sources. The third stage was the review and content analysis of the selected literature to identify key concepts, research findings, and patterns or themes related to the role of technology in supporting bilingual learning (Dinda et al., 2025).

Data analysis was conducted using a descriptive-qualitative approach by grouping information based on key themes, such as the type of technology used, the learning strategies implemented, and its impact on students' language skills. Content analysis techniques were used to systematically interpret the meaning of various sources, resulting in a structured and in-depth understanding. This method enabled researchers to integrate various research findings to obtain a more comprehensive picture of the effectiveness of technology in bilingual learning.

Furthermore, this study also references literature discussing the use of digital learning media and interactive technologies, such as multimedia and Augmented Reality-based applications, which have been shown to increase student effectiveness and engagement in language learning (Rahayu et al., 2024). Therefore, the results of this study are expected to provide a synthesis of relevant knowledge and serve as a conceptual basis for understanding the role of technology in the context of bilingual learning.

RESULTS & DISCUSSION

Based on a review of Pauline Gibbons's thinking, Pacheco's research on multimodal scaffolding in the Journal of Literacy Research, and various other studies on blended learning in bilingual learning in elementary schools, it reveals a fundamental conceptual shift in scaffolding practices in the digital age. This shift extends beyond the use of technological devices to encompass how learning support is interpreted, delivered, and internalized by students. In the classical perspective developed by Gibbons, scaffolding is understood as temporary assistance provided by teachers through targeted and responsive interactions. This support can take the form of language modeling, reformulating student utterances, structured questions, or providing context to clarify meaning. The core of this approach lies in the social relationship between teacher and student: the teacher acts as an active mediator who gradually reduces support as the student's competence



increases. Thus, scaffolding is dialogic, flexible, and highly dependent on the teacher's pedagogical sensitivity to the students' linguistic needs.

Recent literature shows that in the context of technology-based bilingual learning, this form of support is no longer limited to face-to-face interactions. The integration of technology has given rise to a new mediation pattern that can be understood as distributed scaffolding, namely support spread across various digital devices and features. This distribution of support is evident in several key forms.

The findings indicate that technology-mediated language learning provides multiple forms of instructional support that facilitate students' comprehension and language development. One important contribution lies in the use of interactive multimedia, including visuals, audio, and animations, which enable students to process information through multiple representational channels simultaneously. Visual elements help clarify vocabulary and contextual references, audio strengthens pronunciation and listening comprehension, while animations facilitate the understanding of processes, actions, and abstract concepts. In this way, technology functions not merely as a medium for delivering information but also as a scaffold that reduces linguistic ambiguity and enhances students' conceptual understanding. In addition, the integration of automatic feedback features enables students to receive immediate corrections on grammatical errors, vocabulary choices, and language use, thereby accelerating the learning cycle without requiring them to wait for teacher intervention. The effectiveness of this feedback, however, depends on its accuracy, contextual relevance, and alignment with authentic communication tasks. The learning process is further supported by bilingual subtitles and digital dictionaries, which facilitate purposeful translanguaging practices by helping students connect their first and second languages while maintaining opportunities to negotiate meaning during classroom interactions. Furthermore, online collaborative platforms, such as discussion forums, shared documents, and video-based communication tools, expand the learning environment beyond teacher-centered instruction by encouraging peer interaction, collaborative knowledge construction, and mutual feedback. Collectively, these technological features create an integrated learning ecosystem that supports cognitive, linguistic, and social aspects of language learning, enabling students to become more active, independent, and engaged participants in the learning process.

These findings suggest that technology can expand teachers' mediation capacity by providing an additional layer of support that students can access independently. However, the presence of digital features does not automatically result in effective scaffolding. Technology is inherently neutral; it only functions as a scaffold when it is consciously designed and integrated within a clear, structured instructional framework, and adheres to the principle of gradual release of support. This is where a significant conceptual issue arises. If support is entirely shifted to digital systems without the teacher's reflective involvement, the sociocultural dimension at the heart of scaffolding has the potential to be weakened. In such circumstances, technology can shift from its role as a learning mediator to merely a presenter of material, even risking additional cognitive load.

Therefore, technology is more appropriately positioned as an augmentative scaffold, a tool that strengthens and expands the teacher's mediation role, rather than replacing it. Teachers retain



a central role in determining when to use digital support, regulating its intensity and duration, and ensuring the transition to language independence. Thus, the transformation of scaffolding in the digital age is not a shift from humans to machines, but rather a restructuring of the learning ecosystem. The scaffolding process becomes a collaboration between human interaction, technological devices, and the social context of the bilingual classroom. The primary challenge lies not in adopting the technology itself, but in designing integrations that align with the principles of language development and the underlying sociocultural theory.

A review of various studies on multimodal learning, including those published in the Journal of Literacy Research, shows that elementary school bilingual students benefit optimally when meaning is presented not solely through text, but through a combination of various representational systems such as written text, images, audio, and movement. However, it is important to clarify the conceptual rationale and pedagogical mechanisms that make this integration function as scaffolding, rather than simply a variation of learning media.

From a cognitive perspective, a multimodal approach contributes to managing information processing load when students encounter new vocabulary or structures in a second language. Presenting words with contextual illustrations and audio pronunciations allows for the formation of multiple verbal and visual associations that strengthen memory retention. In the context of bilingual learning, this mechanism is particularly relevant because students not only learn new linguistic forms but also build conceptual bridges between their first and second languages. However, this cognitive load-reducing effect is situational. If the visual or audio elements are not aligned with the language learning objectives, such integration has the potential to increase distraction and cognitive load. Therefore, multimodality can function as scaffolding only if each element is designed to mutually reinforce meaning-making, rather than compete for students' attention.

The integration of text, images, and audio plays a role in strengthening cross-language connections through semantic associations. For example, when students see a picture of an "apple" alongside text and pronunciation in English, the meaning-making process does not always depend on explicit translation into the first language. The relatively universal nature of visual representations allows concepts to be directly understood in the target language. This approach reduces reliance on literal translation and encourages the formation of a more independent conceptual system in the second language.

The participation dimension of learning is also influenced by a multimodal approach. Elementary school students tend to be more responsive to visual and auditory stimuli than to text-only exposure. Media such as interactive videos or audio recordings provide opportunities for more active engagement. This engagement is important because language development is determined not only by input received but also by opportunities to produce output, both spoken and written. Visual and audio support can boost students' confidence in attempting to use a second language productively.

Within this framework, the success of bilingual learning is no longer solely measured by grammatical accuracy or language structure test scores. Language competence needs to be understood as the ability to construct and communicate meaning through a variety of semiotic



resources. Thus, language literacy and multimodal literacy become two interrelated dimensions. Students are not only required to be grammatically correct, but also to be able to select and utilize various representational resources to convey meaning effectively. Consequently, technological scaffolding encourages a paradigm shift in bilingual learning: from a structural approach that focuses solely on linguistic form to a multimodal and contextual approach that views language as a complex social and semiotic practice.

Studies on blended learning at the elementary school level show that the combination of face-to-face and online learning opens up the possibility of creating more continuous learning support than conventional models. In traditional classes, scaffolding generally stops when the learning session ends. Conversely, in blended schemes, support can be extended through digital platforms so that the learning process is not interrupted by class time constraints. The results of a synthesis of various studies reveal several key trends.

First, online practice contributes to strengthening vocabulary retention because students have the opportunity for structured repetition outside of school hours. In language acquisition, especially in bilingual contexts, repeated exposure is crucial to help students internalize the connection between form and meaning.

Second, the digital recording feature provides a psychologically safer space for speaking practice. Many bilingual students experience anxiety when speaking live in front of a class. The ability to record, listen back, and revise one's own speech creates a reflective space rarely available in spontaneous interactions. This mechanism can be understood as a form of regulatory scaffolding, as it helps students monitor and control their language production independently.

Third, the online monitoring system provides teachers with more systematic developmental data. Information regarding practice frequency, error patterns, and individual progress allows teachers to design more targeted interventions for subsequent face-to-face sessions. Thus, blended learning creates a more continuous feedback loop between online activities and in-person classroom interactions.

However, this continuity of support also carries potential risks. Overreliance on visual aids, subtitles, or automatic translation can hinder the process of achieving linguistic independence. If these features are used without a gradual tapering strategy, students may remain in the intensive support phase without truly transitioning to autonomy. Therefore, implementing the principle of gradual release of responsibility is crucial in blended learning design. Early stages can involve full multimodal support. In intermediate stages, visual aids or translation begin to be reduced. In advanced stages, students are guided to produce language with minimal digital support. This gradual structure ensures that technology serves as a bridge to independence, not a permanent crutch.

Thus, blended learning does not automatically guarantee the creation of sustainable scaffolding. Its effectiveness is largely determined by its design as a transition system from intensive support to language autonomy. Technology provides the means and space, but the direction and quality of development remain dependent on instructional design and the teacher's professional judgment.



The results of this study demonstrate the need to reexamine the concept of scaffolding in the context of digital learning. In the classical framework, largely developed by Pauline Gibbons, scaffolding is understood as a temporary, adaptive, interactional practice centered on the direct relationship between teacher and student. Support is provided through directed dialogue and gradually reduced as student competency increases. However, when technology is systematically integrated into bilingual learning, this pattern of support is no longer solely linear and interpersonal. The mediation structure becomes more complex and distributed. Scaffolding needs to be understood as a distributed ecosystem of mediation, where the mediation process occurs through both human interaction and digital artifacts. Teachers, software, multimedia content, and interactions between students form an interconnected network of support. Within this framework, technology is not simply an additional tool, but rather an integral part of a mediating system that influences how students access, process, and produce language.

This conceptual reconstruction carries significant theoretical implications. While previously scaffolding relied heavily on teachers' ability to identify and respond to the zone of proximal development, in the digital context, the analysis needs to be expanded to include the role of technological features in shaping this zone. Automatic feedback, visual aids, or adaptive systems can accelerate the process of achieving independence, but they also have the potential to maintain dependency if not designed with the principle of gradually reducing support. Therefore, indicators of successful scaffolding in digital environments need to be reformulated to consider the interaction between pedagogical design and technological characteristics.

Furthermore, bilingual learning is no longer adequate if understood solely as a process of mastering language structures. The integration of technology broadens the scope of competencies involved, including digital literacy and multimodal skills. Students learn not only to construct grammatically correct sentences but also to manage various media representations, interpret visual symbols, and participate in digital communication spaces. Thus, language development and digital literacy development become two interconnected processes that cannot be separated conceptually. This complexity demands both methodological and epistemological consequences. Technological scaffolding practices encompass both quantitative dimensions such as increased vocabulary or intensity of online participation and qualitative dimensions such as student perceptions of digital support, levels of confidence, or established interaction patterns. Therefore, a mixed-methods approach is not simply a technical option for data enrichment, but rather a conceptual necessity to capture the multidimensional nature of scaffolding in the digital learning ecosystem however, classroom practice cannot be separated from broader structural support. At the institutional and policy levels, the implementation of technological scaffolding in bilingual learning requires systemic support that goes beyond the mere provision of devices. Teacher digital literacy training needs to be oriented toward pedagogical integration rather than just technical mastery, so that teachers are able to connect digital tools with language-learning objectives and scaffolding strategies; recent studies on teacher digital literacy highlight that training which focuses on instructional design and reflective practice is more impactful than training that only introduces platforms and applications (Hapsari & Santoso, 2023; Situmorang, 2022; Putra & Amalia, 2023). In



addition, schools must ensure adequate infrastructure and equitable access to devices, because gaps in connectivity and hardware can undermine the potential of technology to support bilingual learners and instead widen existing disparities. A curriculum that explicitly incorporates technology as part of language learning strategies is also essential, embedding digital tools in learning outcomes, materials, and assessment, rather than treating them as optional add-ons (Widodo, 2023; Rahmat, 2021).

Within this institutional framework, the findings of the present study indicate that technological scaffolding holds significant potential to support bilingual learning in elementary schools, but this potential is not inherently contained in the technology itself. Pedagogical value does not reside in devices or applications per se; it emerges from the way teachers design tasks, structure interactions, and reflect on learners' responses when using those tools. Recent work on digital learning media for second language development in children shows that technology is most effective when it is deliberately aligned with language objectives, multimodal input, and opportunities for meaningful interaction, rather than used sporadically as mere "media" (misalnya scoping review tentang digital learning media dalam pembelajaran bahasa kedua anak usia sekolah dasar, 2024). In this regard, the contribution of this study is to demonstrate how technological scaffolding can be integrated into bilingual pedagogy as structured support that systematically targets students' receptive and productive abilities in both languages, instead of simply digitizing existing materials.

Effective implementation of technological scaffolding depends on several interrelated factors that must be carefully considered. First, it needs to be aligned with sociocultural principles of scaffolding, where support is contingent, dialogic, and gradually withdrawn as learners gain competence; recent discussions on digital scaffolding emphasize that technology should facilitate contingent assistance (e.g., hints, examples, feedback) that responds to learners' current level rather than offering static, one-size-fits-all support. Second, learning designs must take into account the linguistic context and cognitive development of students, acknowledging that bilingual learners draw on both languages and benefit from opportunities for translanguaging and negotiation of meaning, not just direct translation. Third, a balanced integration between human and digital mediation is crucial: studies on online language learning with scaffolding approaches over the past five years consistently show that digital tools are most effective when they augment, rather than replace, teacher guidance and peer collaboration, creating a richer ecology of support. Finally, comprehensive evaluation through mixed-methods approaches is needed to capture both quantitative gains (such as test scores or vocabulary growth) and qualitative dimensions (such as engagement, identity, confidence, and perceived autonomy), so that the impact of technological scaffolding on bilingual learning can be understood more holistically.

In this sense, technological scaffolding should be viewed not merely as a technical innovation, but as a form of pedagogical transformation. Such transformation calls for ongoing integration of theory, classroom practice, and critical reflection, in which teachers, curriculum developers, and school leaders jointly interpret data, refine designs, and adjust policies over time. Recent studies on teacher readiness for curriculum and digital transformation underscore that sustained professional



development and collaborative reflection communities are key conditions for meaningful integration of technology in language education (Hapsari & Santoso, 2023; Widodo, 2023). Within this framework, teachers do not act as passive users of technology; they position themselves as designers of a mediating ecosystem that consciously directs all forms of support—human, material, and digital—toward the primary goal: fostering bilingual students’ linguistic independence, so they can access, express, and negotiate meaning across languages with increasing confidence and agency.

CONCLUSION

The way scaffolding has changed in the digital age shows a big shift from direct talks between teachers and students to a more complicated system where people, digital tools, and shared platforms all work together. This study shows that using technology in bilingual teaching makes a big difference by creating interactive, adaptable, and meaningful learning experiences that help students stay involved and feel more confident when communicating.

However, technology alone isn’t enough on its own; it only works well when it’s part of a proper teaching plan that follows social and cultural rules. To avoid students becoming too reliant on digital tools, teachers should carefully plan how much help they provide, gradually reducing support from using many different methods to encouraging students to create language on their own. The main aim of using technology as a support system is to help teachers become builders of a learning space where digital tools help students gain independence and develop strong skills in both digital and language abilities.

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