



DOI:10.22144/ctujoisd.2026.014

Education 4.0 technologies for English language teaching: A meta-synthesis

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Article info.

Received 02 Apr 2025

Revised 11 Jun 2025

Accepted 26 Dec 2025

Keywords

Education 4.0, educational technology, English language teaching, meta-synthesis, technologies for ELT

ABSTRACT

This meta-synthesis aimed to determine the technological landscape of English Language Teaching (ELT) in Asia over the past decade. Through meticulous screening of relevant studies, a thematic analysis of 14 qualitative and primary sources revealed a reliance on internet platforms, mobile devices, gadgets, and robots to facilitate effective English instruction. Yet, a critical evaluation of contemporaneity revealed deficiencies in ELT technologies, ranging from source unreliability to technological unfamiliarity, alongside notable strengths such as user-friendliness and timeliness of information. Addressing these shortcomings demands a concerted effort to equip students and educators with the requisite devices and training. Furthermore, fostering a conducive learning environment mandates tailored curriculum enhancements to bolster technical proficiency and the seamless integration of emerging technologies. Collaboration among parents, institutional leaders, and the educational community is paramount for navigating the adoption of new technologies, both within and beyond the traditional classroom. Delineating clear learning objectives, providing adequate skills training, and instituting appropriate curriculum changes are pivotal in harnessing the full potential of technology for English language learning.

1. INTRODUCTION

Education 4.0 is the new buzzword. The word came as the world faces a new revolution - Fourth Industrial Revolution, aptly called Industrial 4.0. The concept of this phenomenon was first introduced by Swab (2016) in his book, *The Fourth Industrial Revolution*. He is the Founder and the Executive Chairman of the World Economic Forum, a very influential international organization that engages in global business, politics, and educational discourse to improve the condition of humanity (de Oliveira, 2022). The new revolution illustrates how the lines between the physical and digital world are now getting blurred, and it is transforming the way

people live (Schulze, 2019; Alda et al., 2020). Industry 4.0 covers issues such as the Internet of Things (IoT), machine learning, digital industrial technology, intelligent robots and autonomous vehicles, voice-activated assistants, and facial recognition, among others.

As technology rapidly transforms the world, there is also a need to use digital tools to improve the current state of education and prepare students to face Industry 4.0. (Bouronikos, 2022). Schools need to integrate technology and improve curricula to equip students with the skills they would need to work in industries or face challenges that no one has encountered before (Alda et al., 2022). The academe

must face up to the challenge - also aptly called - Education 4.0. This state of education encompasses topics such as blended learning, learning beyond the classroom, innovative learning, technology-enhanced language learning, Computer-Assisted Instruction (CAI), and Mobile Assisted Language Learning, etc.

Education 4.0 represents a transformative approach that equips students with essential digital proficiencies, strategically positioning them for the dynamic demands of tomorrow's workforce (Alda, 2022). Characterized by a collaborative synergy between educators and learners, this paradigm emphasizes the pivotal role of communication in the educational process, fosters authenticity in problem-solving, advocates for immersive learning experiences through gamification and real-world simulations, and leverages Information and Communication Technology (ICT) as a cornerstone (Barreiro & Vladimir, 2022; Alda, 2023). The educational landscape is increasingly prioritizing language acquisition, particularly in the realm of English Language Teaching and Learning. Embracing technological advancements has become a hallmark of this shift, as educators explore avenues such as Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL) to facilitate language acquisition. A comprehensive literature review underscores the significance of technology in fostering meaningful interactions between teachers and students (Ahmadi, 2018). Technological integration not only cultivates students' autonomy in their learning journey but also enhances motivation to master a second language, while providing ample opportunities for teachers to deliver comprehensible input and elicit meaningful output from students. However, it's crucial to recognize that educators require adequate support and training to effectively incorporate technology into English language instruction.

Moreover, there is a notable gap in the global literature on the intersection of Digital English, Education 4.0, and Industry 4.0 (Hariharasudan & Kot, 2018). English Language Education emerges as a focal point within the Asian context, where English serves as a predominant medium of communication across nations (Chang, 2011). A seminal study delved into the emergence of English as an "Asian Language" and the formidable challenges Asian educators encounter in meeting the escalating demand for English proficiency amidst rapid technological advancement. This inquiry

scrutinised various facets of Asian education, including globalisation dynamics, English language policies, and teacher agency, shedding light on the phenomenon of "policy dumping," wherein educational policymakers implement directives without due consideration for the practical challenges faced by educators in the classroom (Hamid, 2016).

In light of these pressing concerns, it becomes evident that a systematic exploration of technology's role in English Language Teaching, particularly within the context of Education 4.0, is warranted, with a specific focus on Asian educational settings.

Although there is a growing body of literature on Education 4.0 and the integration of technology in English Language Teaching (ELT), a comprehensive synthesis of how these technologies have been utilized across different Asian contexts remains limited. There is also a lack of holistic understanding of the types, patterns, and pedagogical implications of these technologies across Asia. Furthermore, previous reviews have often been broad or theoretical, lacking grounded, qualitative analysis of actual ELT practices. Hence, this study endeavors to assess the current landscape of English language instruction in Asian schools, examining the integration of technological tools and methodologies in pedagogical practices. This approach offers both depth and scope, contributing a consolidated view essential for informed policy-making, curriculum development, and teacher training in the region.

1.1. Research questions

This meta-synthesis systematically examines primary qualitative studies published from 2012 to 2022 to uncover trends, themes, and challenges in the use of technology in ELT in Asia. Specifically, this study is guided by the following questions:

1. What Education 4.0 technologies are used in English Language Teaching in Asia?
2. How do these technologies affect teaching practices, learner autonomy, interaction, and language skills?
3. What challenges do educators and learners face in using these technologies for ELT?
4. What themes and implications emerge to inform future ELT practice and policy?

2. MATERIALS AND METHOD

2.1. Research design

This study employed a qualitative meta-synthesis approach to systematically examine the technological landscape of English Language Teaching (ELT) in Asia within the Education 4.0 framework. A configurative synthesis was used to explore embedded themes and to draw insightful patterns across selected studies. The research followed the principles outlined by Walsh and Downe (2005) and Zimmer (2006), ensuring a rigorous process of identifying relevant qualitative studies. Expert validation by educators and technologists ensured the credibility and relevance of the chosen studies, strengthening the interpretative value and trustworthiness of the synthesized findings.

2.2. Search strategy and selection process

Data collection began with an exhaustive Google Scholar search using the software Publish or Perish to identify studies on CALL, MALL, and Education 4.0 in ELT. From 2,500 initial results, articles were filtered using predefined inclusion criteria—published between 2012 and 2022, qualitative in nature, focused on English language instruction, and technology-specific. Articles such as conference proceedings, citations, and quantitative or incomplete studies were excluded. The PRISMA 2020 Flow Diagram was used to document this filtering process, ensuring transparency. The rigorous screening narrowed the final pool to 14 high-quality, peer-reviewed qualitative articles from across Asia.

2.3. Quality assessment and verification

To ensure the integrity of included studies, the Critical Appraisal Skills Programme (CASP) Checklist was employed, evaluating each article for methodological soundness, data collection rigor, and relevance to the study aims. A panel of three domain experts from Cebu Normal University reviewed the shortlisted studies using a comprehensive verification sheet that included metadata such as study objectives, design, sample, and the technological tools used. Their expert judgment led to the exclusion of studies that were redundant, non-English-specific, or lacked clear ELT relevance, resulting in a validated pool of 14 articles. This careful vetting safeguarded the validity of the meta-synthesis outcomes.

2.4. Data extraction

The finalized 14 articles were reviewed thoroughly, with key information on themes, methods, technologies, findings, and implications systematically extracted. Data extraction was guided by the inclusion criteria and structured using Publish or Perish's export features. Boolean keyword combinations ensured relevant hits, while summaries of each article were documented and organized. The extracted data served as the foundation for thematic coding and synthesis, ensuring that only empirically rich and contextually relevant data informed the study.

2.5. Data analysis and theme generation (QDA Miner)

The 14 articles were imported into QDA Miner, a qualitative data analysis software, for coding and theme development. The analysis focused on key sections—Abstract, Discussion, and Conclusion—to maintain consistency and avoid redundancy. Codes were generated inductively, categorized in a tree structure, and subjected to iterative trial-and-error to identify meaningful clusters. The use of QDA Miner enabled systematic tracking, code frequency analysis, and visual representation, thereby enhancing analytical clarity and robustness.

2.6. Data synthesis

A qualitative meta-synthesis technique, grounded in thematic synthesis, was used to organize the coded data into coherent meta-themes. These themes were mapped in an analysis matrix, cross-referencing each article with its country, methodology, key findings, and educational implications. This synthesis illuminated the common threads across diverse contexts while respecting unique local challenges, providing a rich understanding of how Education 4.0 technologies are operationalized in Asian ELT classrooms.

3. RESULTS AND DISCUSSION

This section presents the synthesized findings of 14 qualitative studies on Education 4.0 technologies used in English Language Teaching (ELT) across Asia. The results are organized thematically to capture commonalities and contrasts among the studies. Key themes include the types of technologies employed, the existing technological conditions in classrooms, and the challenges of integrating these technologies into ELT.

3.1. Types of technology

The following discussion provides the different technologies afforded/ used by teachers in Asia in English language teaching. The list is not exhaustive, but it represents what teachers have been using in this region. The technologies are classified into computer-assisted language learning, mobile-assisted language learning, and robot-assisted language learning.

3.1.1. Computer-assisted language learning

Various studies have demonstrated the efficacy of Computer-Assisted Language Learning (CALL) in English language instruction. In China (Li & Zhu, 2013), CALL facilitated collaborative writing through wikis. Similarly, Thailand (Article 8) explored the use of digital games to enhance language communication skills. By modifying a popular online game, researchers investigated its impact on students' willingness to communicate (WTC), highlighting the potential of Digital-game-based Language Learning (DGBLL).

In Taiwan (Yang, 2012), digital storytelling emerged as a powerful tool for language acquisition. Students utilized video editing software to craft narratives, supplemented by digital story maps and storyboards. Meanwhile, Hafner's (2014) research in Hong Kong emphasized the integration of digital video projects into language education, showcasing multimodal scientific documentaries created by students for wider dissemination on platforms like YouTube. A study in Indonesia (Atmojo & Nugroho, 2020) explored diverse applications and platforms for English as a Foreign Language (EFL) instruction, including Google Classroom, Schoology, WhatsApp, and Zoom. These tools supported various aspects of teaching and learning, from communication to assessment. Furthermore, investigations into e-learning in Indonesia (Rahmawati, 2016) highlight both opportunities and challenges, underscoring the need for updated software and improved internet infrastructure.

Lastly, Tseng et al. (2019) delved into the application of the Technological Pedagogical Content Knowledge (TPACK) framework in web-conferencing teaching. Pre-service teachers utilized Adobe Connect to integrate technology, pedagogy, and subject matter expertise effectively. Through features like video calls and interactive whiteboards, TPACK was applied to enhance distance learning experiences, showcasing the dynamic potential of technology integration in education.

3.1.2. Mobile-assisted language learning

Mobile-Assisted Language Learning (MALL) has emerged as a dynamic approach to language education (Alda, 2018), leveraging the ubiquity of smart devices for learning purposes. For instance, China (Gao & Zhang, 2020) showcases the utilization of various platforms like Chaoxing, Ding Talk, MOOC, WeChat, and QQ during the pandemic. These applications facilitated communication between teachers and students, enabling resource sharing, course delivery, and collaboration through mobile devices. Similarly, Foomani and Hedayati (2016) in Pakistan exemplify MALL's versatility in language learning design. Students utilized mobile devices to capture photos representing idioms, later sharing them via Padlet, an interactive digital wall platform, for collaborative learning experiences. Also, Gurkan (2018) introduces VocaStyle, a mobile-assisted vocabulary-learning application designed to supplement English course materials. This innovative tool enhances learning through text, audio, graphic, and video annotations accessible on mobile devices. Pakistan (Ali et al., 2020) investigates teachers' perspectives on MALL applications, emphasising the use of mobile device features and social media apps to enrich language teaching practices.

Further exploration in the United Arab Emirates (Engin, 2014) focuses on student-created digital videos to enhance writing skills. Utilizing a multimodal environment and the flipped classroom model, students accessed digital tutorials and utilized Blackboard, a learning management system, highlighting the efficacy of MALL and CALL in writing instruction. Lastly, Article 11 examines the integration of social networking tools, particularly Facebook, into the writing classroom. Yunus et al. (2012) scrutinize the strengths and weaknesses of social media tools for teaching English, shedding light on their potential in language education.

3.1.3. Robot-assisted language learning

In Korea, Shin and Jeong-Hye (2017) explored the use of a special telepresence robot, Robosem, to gauge student reactions to Robot-Assisted Language Learning (RALL). Korean students engaged in conversations with an American peer through three different conferencing setups, including interactions facilitated by a life-sized projection through Robosem. This study sheds light on RALL's potential to enhance language learning experiences.

Across Asia, schools are integrating technology such as Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL) into their educational practices. Li & Zhu (2013) highlighted the role of Digital-game Based Language Learning, while the study conducted in Korea (Shin & Jeong-Hye, 2017) focused on RALL, demonstrating the diverse technological landscape shaping language education in the region. These studies underscore the efforts of Asian educators to leverage technology for more engaging and interactive learning environments.

To aid educators in effectively incorporating technology, it is crucial to note the available hardware and software options. By leveraging appropriate tools, teachers can enhance their efficiency and effectiveness in language instruction, ultimately benefiting their students' learning outcomes.

3.2. Existing technological conditions

The 14 articles extensively explored the technological landscape experienced by students and teachers in ELT. Amidst technological advancements, both educators and learners play active roles in adapting to these changes, shaping the future of teaching and learning. Researchers delved into students' and teachers' reactions, insights, experiences, and opinions to understand the impact of technology on language teaching. It underscores the pivotal role of individuals in navigating the evolving landscape of education.

3.2.1. Social interactions

Integrating technology into social interactions between students and teachers is significant, enhancing offline exchanges when paired with appropriate software. Effective social interaction is facilitated by suitable technology. In (Hafner, 2014) students collaborated in teams to create digital videos, engaging in various processes such as reading, scripting, filming, and editing. Through workshops and in-class sessions, they successfully produced multimedia ensembles, making interactive choices in their creations. Research on learning idioms (Foomani & Hedayati, 2016) observed students enhancing their skills through online peer observation and artefact review, fostering fresh perspectives on learning in a virtual environment. Ali et al. (2020) confirmed that Mobile-assisted Language Learning (MALL) fosters social connectivity among students, promoting collaborative learning and communication via

platforms like WhatsApp and social networking sites.

Also, children's interaction with a robot (Shin & Jeong-Hye, 2017) showcased closeness and connectedness despite geographical distance, with students expressing genuine interaction and emotional connection, bridging physical gaps through the robot. Peer collaboration in China (Li & Zhu, 2013), as seen in wiki-based language learning, demonstrated resource pooling and collaborative writing, yielding varied interaction patterns and overall student satisfaction. Digital game-based learning encouraged active participation and peer interaction, fostering a supportive environment, though some students expressed apprehension about spontaneous speech (Reinders & Wattana, 2015). Creating digital videos (Engin, 2014) led to recognition of students' expertise, transcending into other learning areas, yet also revealed a lack of confidence in peers' content, highlighting the importance of trust in knowledge sharing.

These findings echo Baytak et al. (2011), emphasizing students' enjoyment in sharing online, underscoring the potential of technology integration for self-improvement. Recognizing students as primary beneficiaries, educators should prioritise opportunities for social interaction when designing technology-infused lessons.

3.2.2. Self-management/autonomy

The integration of technology empowers students to cultivate self-management and autonomy, enhancing productivity through personalized learning goals and pace regulation. Selecting suitable technology in classrooms fosters independent learning. In Yang (2012), students create digital videos to address dilemmas they face as English learners. Ting-Fen exemplifies autonomy by tailoring content to sustain audience attention, demonstrating thoughtful consideration of information processing capacity. Hafner (2014) highlights students' self-management development during the creation of scientific documentaries, where authentic communicative experiences enhance awareness of communicative competence.

Learner autonomy is also evident in learner-generated context (LGC) creation for idiomatic study via Mobile-assisted Language Learning (MALL), fostering active engagement and resource modification (Foomani & Hedayati, 2016). VocaStyle, a vocabulary-learning app, promotes autonomy by catering to diverse learning styles and

providing accessible information on mobile devices. Students, even self-described slow learners, benefit from self-paced learning, fostering motivation and readiness (Gurkan, 2018). In the United Arab Emirates (Engin, 2014), students independently research and evaluate content for video creation, yet express concerns about the accuracy of resources, underscoring the importance of accurate autonomous learning. To scaffold independent learning, teachers must design activities that gradually increase in complexity, providing students with opportunities to make informed decisions. Balancing autonomy with accuracy ensures effective learning outcomes.

3.2.3. Student learning style

As education trends toward student-centred learning, attention to individual learning styles becomes paramount. Common styles include visual, auditory, logical, verbal, kinesthetic, interpersonal, and intrapersonal (Operiano, 2022). Articles explore how technology can cater to diverse learning preferences. In the VocaStyle app study, auditory learners found audio annotations beneficial, while visual learners appreciated graphic annotations. Both groups favored video annotations, with learners preferring visuals over auditory input (Gurkan, 2018). MALL studies highlighted how mobile devices empower students to identify and develop personalized learning styles, fostering concentration and motivation (Foomani & Hedayati, 2016; Ali et al., 2020). The Robosem interaction study (Shin & Jeong-Hye, 2017) underscored how individual differences are accommodated, boosting confidence and engagement for shy or easily distracted students through verbal and nonverbal cues.

However, challenges arise as not all students embrace technology for learning. Negative sentiments emerged in the CALL video game study (Reinders & Wattana, 2015), where language preferences hindered enjoyment. Some students preferred traditional teacher explanations, expressing concerns about content accuracy, particularly in the flipped classroom model. Online teaching during the pandemic further highlighted the challenge of accommodating diverse learning styles. Sourcing content that suits various preferences proved challenging. Recognizing these differences, English teaching must adapt to students' unique needs, ensuring technology-enhanced activities cater to diverse learning styles. Creative

use of technology in classrooms can provide tailored learning experiences for each student.

3.2.4. Mastery of English skills

The impact of technology on student mastery of English skills is a crucial aspect examined in this study of ELT technologies. In Gao & Zhang (2020), students engaged in idiomatic expressions, creating artefacts to symbolise them. Peer feedback from online assessments enhanced their understanding, though teacher involvement in correcting inaccuracies was deemed necessary. Article 3 highlighted a vocabulary app's efficacy in aiding word retention and comprehension, providing organized content and motivation for learning. MALL, in Ali, et al. (2020), significantly improved students' learning experiences, fostering focus, attention, and motivation, ultimately enhancing performance and learning outcomes. Li & Zhu (2013) found wiki-mediated writing tasks to be beneficial for practicing writing skills, with students voluntarily participating in discussions and appreciating the learning opportunities provided. In a study on language-learning games (Reinders & Wattana, 2015), students reported increased language production, greater motivation, and reduced communication anxiety. Games facilitated faster sentence production and improved communicative competence. Engin, (2014) showcased how online research for video creation deepened students' understanding of topics, promoting language development through cognitive processes and content accuracy focus.

However, challenges arise in accommodating students' diverse cognitive abilities and learning styles, as highlighted in Atmojo & Nugroho (2020). Some students require additional guidance, and the lack of personalized learning experiences may hinder optimal mastery. Ultimately, ELT aims for communicative competence, achievable through mastery of English skills. Teachers play a crucial role in leveraging technology, such as apps and games, to promote skill mastery and meet individual learning needs.

3.2.5. Practiced pedagogy

The methodology and instructional practices employed by teachers significantly influence students' language use and performance. Understanding how teachers perceive technology's role in education is essential for optimizing teaching and learning experiences. In Gao & Zhang (2020), a constructivist approach guided the study,

emphasizing the co-creation of knowledge by students and teachers within cultural and social contexts. They explored how individuals construct meaning, highlighting the importance of understanding diverse perspectives. A study on video projects as multimodal ensembles (Hafner, 2014) showcased a project-based learning approach in an English for science course, promoting multiliteracy practices. Teachers designed projects simulating real-life challenges to enhance students' knowledge and skills.

In response to pandemic challenges, teachers employed synchronous and asynchronous online teaching modes, focusing on content mastery, technology integration, and pedagogical application in foreign language learning (Atmojo & Nugroho, 2020). Pedagogy played a crucial role in e-learning implementation (Rahmawati, 2016), with teachers acting as guides and providing varied e-learning approaches. Timely feedback was essential to deter cheating and plagiarism. The application of Technological Pedagogical Content Knowledge (TPACK) in teaching has also been emphasized, integrating context clues, feedback strategies, and interactive tools to sustain student engagement and facilitate distance learning (Tseng et al., 2019).

In MALL studies, the Seamless Learning Approach promoted collaborative learning and constructivist principles, leveraging mobile technology to facilitate learning at the point of need (Foomani & Hedayati, 2016; Gurkan, 2018; Ali, et al., 2020). Teachers embraced student-centred approaches and abandoned traditional teacher-centred methods, becoming facilitators and mentors in the learning process (Ali et al., 2020). Wikis proved effective for improving writing through small group interaction, showcasing a novel instructional strategy focused on language proficiency and member collaboration (Li & Zhu, 2013). Each teacher's teaching style reflects their pedagogical approach, influencing technology integration in the classroom. Aligning technology with preferred pedagogical methods can enhance teaching effectiveness and student learning outcomes

3.3. Challenges in the integration of these technologies in ELT

Technology has revolutionized English Language learning in Asia, paving the way for significant advancements as education transitions to Education 4.0. While its impact is undeniable, assessing its strengths and weaknesses is crucial for effective integration. By understanding past efforts and

identifying future needs, educators can better prepare for the adoption of advanced technologies in ELT across Asia.

3.3.1. Unreliability of sources and unrealistic interactions

Teachers and students face a common challenge: the unreliability of online sources. In the study on SNS integration for writing, the lack of assurance in the accuracy of online information was highlighted, posing risks to language learning. Similarly, in student-produced digital videos, doubts arose of classmates' knowledge. Korean students' interactions with Selina via screens also underscored the unrealism of online communication. These issues highlight the pitfalls of online learning. To address this, teachers must guide students in discerning credible sources and detecting misinformation. Relying solely on search engines is inadequate. Teachers should vigilantly monitor and educate students about the risks associated with unreliable sources.

3.3.2. Limitations/unfamiliarity with technologies

Technology in education often undergoes upgrades and updates, which can lead to limitations and inaccuracies. For instance, the VocaStyle app, despite pilot testing, exhibited bugs in annotations, affecting clarity. Similarly, e-learning platforms like Messenger and Skype faced challenges, including delayed responses and unclear audio, due to poor internet connectivity, as observed during the COVID-19 pandemic in China. Technical issues, including disruptions in sound quality and background noise, were reported on web conferencing platforms, hindering effective communication. Moreover, students encountered difficulties in representing abstract concepts, such as idioms, and hesitated to interact closely with robots due to perceived unfamiliarity. Inconsistencies in chat conversations during video games caused anxiety, while fear of making mistakes impacted students' performance in digital story creation. Teachers' limited mastery of information technology also posed challenges in online teaching, emphasizing the importance of technological proficiency for successful instruction. Furthermore, students faced barriers such as poor-quality touchscreens and inadequate internet access, which impeded language learning. Addressing these issues requires investment in facilities, training, and infrastructure to ensure equitable access to technology-enhanced education. Administrators

play a crucial role in securing resources and funding to support technological integration in ELT.

4. CONCLUSION AND RECOMMENDATIONS

In conclusion, the meta-synthesis of Education 4.0 technologies for English Language Teaching (ELT) underscores the diverse range of technologies utilized in Asian classrooms over the past decade. These include computer-assisted language learning (CALL), mobile-assisted language learning (MALL), robot-mediated communication, video production, computer-mediated interactions, gameplay, and web-conferencing teaching, as highlighted across various studies. Such technologies have facilitated a shift towards authentic learning environments that cater to individual student preferences and learning styles. Despite notable strengths, shortcomings such as technical issues and overreliance on technology require careful consideration.

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- Moving forward, it is imperative to delineate clear learning goals and provide adequate skills training for both students and teachers. This necessitates a reconceptualization of technology's role in achieving language learning objectives, emphasizing communicative competence. Moreover, appropriate curriculum changes, backed by institutional support from administrators and educators, are crucial for successful technology integration.
- Further studies should focus on the application of technology across various literacy domains, including collaborative writing, video creation, digital game-based learning, and mobile application annotations. Through concerted efforts and strategic implementation, the integration of technology holds immense potential to revolutionize language learning experiences in Asian classrooms.
- #### CONFLICT OF INTEREST
- The authors declare no conflict of interest.
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