Investigating the Needs and Potential of Interactive Media in an AI-Enhanced Constructivist Learning Environment for English Vocabulary Acquisition

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Abstract

This study investigates the needs and potential of interactive media in an AI-enhanced constructivist learning environment for English vocabulary acquisition among elementary school students. The research employs a mixed-methods approach, involving 120 fifth-grade students and 10 English language teachers selected through stratified random sampling from four schools in Lopburi Province, Thailand. Data collection includes surveys on students' learning needs, difficulties, and preferences, as well as interviews with teachers regarding their perceptions of current teaching practices and the potential of integrating AI and interactive media in vocabulary instruction. Quantitative data analysis reveals that 75% of students find vocabulary learning challenging, with 68% expressing a preference for interactive media. Qualitative findings indicate that 80% of teachers acknowledge the limitations of traditional teaching methods and 90% recognize the potential benefits of AI and interactive media in enhancing vocabulary acquisition. However, 60% of teachers express concerns about the lack of technological infrastructure and training. These findings serve as a foundation for designing and developing an innovative learning system that effectively addresses the identified needs and optimizes the potential of emerging technologies in language education. This research contributes to the advancement of technology-enhanced language learning and offers practical implications for educators and researchers in the field.

Keywords: AI-enhanced learning, constructivist learning environment, English vocabulary acquisition, interactive media, vocabulary retention

Introduction

Background and Context

English language proficiency has become an essential competency in the globalized world, serving as a gateway to educational advancement, career opportunities, and cross-cultural communication (Crystal, 2019). In Thailand, the Office of Basic Education Commission (2022) has emphasized the critical importance of developing strong English language foundations from the elementary level, recognizing that English proficiency significantly impacts students' access to knowledge and future opportunities. However, despite these recognized imperatives, Thai students continue to face substantial challenges in English language acquisition.

The National Educational Quality Assessment through standardized tests (O-NET) for Grade 6 elementary students in English revealed that the average score was only 33.49%, significantly lower than the 50% standard criterion established by the Ministry of Education (National Institute of Educational Testing Service, 2024). This alarming statistic reflects the persistent English learning difficulties among Thai students and indicates that current instructional approaches fail to meet learners' needs effectively. The situation demands innovative pedagogical interventions that can address these challenges comprehensively.

Research on second language vocabulary learning has consistently identified vocabulary retention as a central challenge for language learners worldwide. Karatas et al. (2025) and Nakata and Elgort (2020) have demonstrated that learners' primary difficulty lies not in the initial memorization of vocabulary but rather in the preservation of lexical knowledge in long-term memory and its appropriate application across various contexts. A comprehensive meta-analysis by Uchihara et al. (2023) revealed that second language learners typically forget approximately 60-70% of newly learned vocabulary within 2–4 weeks after initial learning without regular review or consistent usage.

The vocabulary retention challenge is particularly pronounced in the Thai educational context. Suwimol Tirakanant (2022) found that Thai students tend to forget English vocabulary within an even shorter timeframe—typically 2–3 weeks after instruction—without systematic review or contextual application. This accelerated forgetting rate can be attributed to the specific characteristics of English learning in Thailand as an English as a Foreign Language (EFL) context, where students have limited opportunities to encounter and use English in daily life (Sureepong, 2018). Furthermore, Phoocharoensil et al. (2023) found that Thai students predominantly rely on traditional vocabulary learning strategies such as rote memorization and bilingual dictionary consultation rather than more effective approaches like contextual learning. The lack of vocabulary retention has cascading effects on all language skills, as vocabulary serves as the fundamental building block of language communication (Schmitt et al., 2011; Stæhr, 2008).

Statement of the Problem

The convergence of low English achievement scores, significant vocabulary retention challenges, and the limitations of traditional teaching methods in the Thai educational context creates an urgent need for innovative instructional approaches. The contemporary digital landscape, characterized by rapid technological advancement and the emergence of artificial intelligence applications in education, presents both challenges and opportunities for addressing these pedagogical concerns. Interactive media and AI-enhanced learning

environments offer promising solutions by providing personalized, adaptive, and engaging learning experiences that can address individual learner needs while maintaining motivation and interest. However, the successful integration of these technologies in Thai elementary English classrooms requires a thorough understanding of students' specific learning needs, preferences, and the potential barriers to implementation.

Research Objectives and Questions

This study aims to: (1) investigate the vocabulary learning needs and difficulties experienced by fifth-grade elementary students in Thailand, (2) assess students' preferences for interactive learning media and AI-enhanced features, (3) explore teachers' perceptions of current teaching practices and their attitudes toward integrating AI and interactive media in vocabulary instruction, (4) evaluate the technological infrastructure and readiness of schools and teachers for implementing technology-enhanced learning, and (5) provide evidence-based recommendations for designing Interactive Media in an AI-Enhanced Constructivist Learning Environment for English vocabulary acquisition.

The study addresses the following research questions: What are the primary vocabulary learning difficulties and needs of fifth-grade elementary students? What are students' preferences regarding interactive media features and AI-enhanced learning capabilities? How do teachers perceive the limitations of current teaching methods and the potential of AI and interactive media in vocabulary instruction? What is the current state of technological infrastructure and teacher readiness for implementing technology-enhanced vocabulary instruction? What are the evidence-based recommendations for designing Interactive Media in an AI-Enhanced Constructivist Learning Environment that addresses the identified needs and leverages the available potential?

This research contributes to the field of educational technology and second language acquisition by providing empirical evidence regarding the specific vocabulary learning needs and challenges faced by Thai elementary students, filling a gap in the literature regarding needs assessment for technology-enhanced language learning in the Thai context. The study offers insights into student preferences for interactive media features, identifies potential barriers to implementation, and informs policy decisions regarding resource allocation for technology integration in education.

Literature Review

Vocabulary Acquisition and Retention in Second Language Learning

Vocabulary acquisition constitutes a fundamental component of second language learning, with lexical knowledge serving as the foundation for all language skills (Nation, 2022; Schmitt & Schmitt, 2021). Research has consistently demonstrated that vocabulary size and depth significantly predict learners' ability to comprehend spoken and written language, produce meaningful utterances, and engage in successful communication (Schmitt et al., 2011). However, the challenge of vocabulary retention has been extensively documented in second language acquisition research. Nakata and Elgort (2020) synthesized findings indicating that learners often demonstrate adequate short-term recall of vocabulary but struggle to maintain this knowledge over extended periods. This retention challenge is particularly pronounced in foreign language contexts where learners have limited exposure to the target language outside formal instruction.

Recent literature has emphasized the role of active engagement in vocabulary learning. Teng (2022) found that multimodal input significantly enhanced vocabulary retention compared to text-only presentation, suggesting that engaging multiple sensory channels supports deeper encoding and more durable memory traces. Chang (2023) demonstrated that repeated oral reading practice significantly improved retention of high-frequency multiword items among EFL learners, highlighting the importance of productive language use in vocabulary consolidation. Similarly, Garcés-Manzanera (2023) found that incidental vocabulary learning through communicative tasks promoted better retention than explicit vocabulary instruction alone, suggesting that contextualized learning experiences support more robust lexical development.

Constructivist Learning Theory and AI in Education

Constructivist learning theory, rooted in the foundational work of Piaget and Vygotsky (1978), posits that learners actively construct knowledge through interaction with their environment and social contexts rather than passively receiving information (Fosnot & Perry, 2021). This theoretical framework emphasizes the importance of meaningful learning experiences, social interaction, and the connection of new knowledge to prior understanding. The integration of technology in constructivist learning environments has been explored extensively in recent research. Zin et al. (2024) examined technological advancements in learning management systems that support constructivist pedagogy, finding that effective systems provide opportunities for exploration, collaboration, and knowledge construction. Quoc and Van (2023) demonstrated that social constructivist approaches enhanced lexical retention among EFL learners, with technology-mediated collaborative activities promoting deeper vocabulary processing and more durable learning outcomes.

Kahn and Winters (2021) traced the historical relationship between constructionism and artificial intelligence, arguing that AI technologies can support constructivist learning when designed to facilitate exploration, experimentation, and knowledge building. The application of artificial intelligence in education has expanded rapidly in recent years, offering new possibilities for personalized, adaptive, and intelligent learning systems (Doroudi, 2022; Holmes & Tuomi, 2022). AI technologies in education encompass a broad range of applications, including intelligent tutoring systems, automated assessment, learning analytics, and adaptive content delivery. Almasri (2024) conducted a systematic review finding positive effects on student learning outcomes, engagement, and attitudes, while also identifying implementation challenges related to teacher preparation, technological infrastructure, and integration with existing curricula. Gibson et al. (2023) analyzed learning theories relevant to AI-enhanced learning, proposing frameworks for understanding how AI can support different types of learning processes. In the context of language learning, AI applications have shown particular promise for vocabulary instruction. Hsu et al. (2023) investigated AI image recognition for vocabulary acquisition, finding that AI-supported learning strategies reduced learning anxiety while improving vocabulary outcomes. Lee et al. (2022) developed an AI English learning support system that facilitated learner-generated context-based learning, demonstrating improved engagement and learning effectiveness.

Interactive Media and Gamification in Language Learning

Interactive media technologies have transformed educational possibilities by enabling engaging, multimodal, and adaptive learning experiences. Arabiat et al. (2022) conducted a systematic review of interactive technology use and child development, finding positive effects on cognitive, social, and language development when technologies were appropriately designed and implemented. Gamification—the application of game design elements in educational contexts—has emerged as a particularly effective approach for enhancing learner motivation and engagement. Zou et al. (2019) comprehensively reviewed digital game-based vocabulary learning research, finding that game-based approaches consistently outperformed traditional instruction in terms of both learning outcomes and learner motivation. The review identified key design features that contribute to effective vocabulary games, including immediate feedback, progressive difficulty, and meaningful rewards.

Chen et al. (2020) investigated the impact of integrating vocabulary exercises into adventure video games, finding significant improvements in vocabulary learning compared to conventional instruction. The study highlighted the importance of meaningful integration where vocabulary learning serves game objectives rather than appearing as disconnected educational content. Lee (2022) examined factors affecting incidental vocabulary acquisition and retention in game-enhanced environments, identifying engagement, repetition, and contextual embedding as key predictors of learning success. Sayed (2022) specifically examined competitive digital games for vocabulary retention among primary school students, finding that game-based competition enhanced both immediate learning and delayed retention. Harrington and Mellors (2021) further explored the role of gamification in promoting student success and retention, proposing design principles for effective educational gamification that balance challenge, achievement, and social interaction.

Despite the growing body of research on AI in education and interactive media for language learning, significant gaps remain in understanding the specific needs and potential for implementing these technologies in Thai elementary English education. While international research provides valuable insights, the unique characteristics of the Thai EFL context—including limited English exposure, cultural factors, and infrastructure constraints—necessitate context-specific investigation. Furthermore, comprehensive needs assessments that integrate student, teacher, and institutional perspectives remain scarce in the literature. This study addresses these gaps by conducting a comprehensive investigation of vocabulary learning needs, interactive media preferences, and implementation readiness in the Thai elementary context. The research is grounded in constructivist learning theory and draws on cognitive theories of vocabulary acquisition, particularly dual coding theory (Paivio, 1991) and working memory models (Baddeley, 2012), to inform the analysis of effective learning approaches.

Research Methodology

Research Design

This study employed a mixed-methods research design, combining quantitative and qualitative approaches to achieve a comprehensive understanding of vocabulary learning needs and the potential for AI-enhanced interactive media in elementary English education. The mixed-methods approach was selected to capitalize on the complementary strengths of quantitative methods for establishing patterns and prevalence and qualitative methods for providing depth, context, and explanatory richness. The convergent parallel design allowed simultaneous data

collection through multiple instruments, with integration occurring during the interpretation phase.

Participants and Setting

The study was conducted in four elementary schools in Lopburi Province, Thailand, selected to represent diverse school contexts within the provincial education system. Participants included 120 fifth-grade students (48.3% male, 51.7% female) and 10 English language teachers. Students were selected through stratified random sampling to ensure representation across schools and academic performance levels. The student sample represented a range of prior English achievement: 15% had achieved excellent grades (A), 30% had good grades (B), 35% had average grades (C), and 20% had below-average grades (D). Additionally, 108 parents or guardians (90% response rate) participated in a supplementary survey to provide contextual information about family support and technology access.

Research Instruments and Data Collection

A comprehensive suite of twelve research instruments was developed to ensure triangulation and provide a multifaceted understanding of the research questions. These instruments included: (1) Student Needs Assessment Questionnaire to identify learning needs and problems; (2) Interactive Media Preference Survey to assess media preferences; (3) Semi-Structured Teacher Interview to explore attitudes and limitations; (4) Technology Infrastructure Assessment to evaluate technology readiness; (5) Vocabulary Pre-Test to measure baseline vocabulary knowledge; (6) Classroom Observation Protocol to observe learning behaviors; (7) Student Focus Group Interview to gain in-depth perspectives; (8) Parent Survey to understand family context; (9) Existing Materials Analysis Checklist to analyze current materials; (10) Researcher's Field Journal to record qualitative context; (11) AI Features Priority Assessment to inform AI feature design; and (12) Digital Literacy Assessment to evaluate students' digital skills.

Data collection was conducted over a seven-week period following institutional approval and informed consent procedures. Quantitative instruments were administered during class time with researcher supervision. Semi-structured teacher interviews lasting 45–60 minutes were conducted individually. Student focus groups, comprising seven students each (28 students total across four groups), were facilitated by the researcher using standardized protocols. Classroom observations were conducted across 12 class periods (three per school), each lasting 50 minutes, using structured observation protocols to record engagement levels, teaching methods, and technology use.

Quantitative data were analyzed using descriptive statistics including means, standard deviations, frequencies, and percentages. Likert-scale items were interpreted using predetermined criteria: 4.50–5.00 (Highest), 3.50–4.49 (High), 2.50–3.49 (Moderate), 1.50–2.49 (Low), and 1.00–1.49 (Lowest). Qualitative data from interviews, focus groups, and field journals were analyzed using thematic analysis following Braun and Clarke's six-phase framework: familiarization, coding, theme development, review, definition, and reporting. Data triangulation was achieved by comparing findings across multiple instruments and participant groups.

Results

Students' Vocabulary Learning Difficulties and Needs

The Student Needs Survey revealed substantial vocabulary learning challenges among participants. Analysis of 5-point Likert scale responses indicated that 75% of students (n = 90) rated vocabulary learning as challenging, with mean scores at or above 3.50. Table 1 presents the detailed breakdown of vocabulary learning difficulties. Long-term retention emerged as the most significant difficulty (M = 4.45, SD = 0.69), followed by understanding word meanings (M = 4.35, SD = 0.72), remembering new vocabulary (M = 4.21, SD = 0.78), correct pronunciation (M = 4.12, SD = 0.81), using vocabulary in sentences (M = 3.89, SD = 0.85), and learning motivation (M = 3.56, SD = 0.92).

Table 1
Vocabulary Learning Difficulties Among Fifth-Grade Students (n = 120)

Difficulty Area	Mean	S.D.	Level
Long-term retention of vocabulary	4.45	0.68	High
Understanding word meanings	4.35	0.72	High
Remembering new vocabulary	4.21	0.78	High
Correct pronunciation	4.12	0.81	High
Using vocabulary in sentences	3.89	0.85	High
Learning motivation	3.54	0.92	Moderate

These findings were corroborated by the vocabulary pre-test results, which revealed that 55% of students (n = 66) scored below satisfactory levels. The mean pre-test score was 24.35 out of 45 points (54.11%), with substantial variation (SD = 8.72). Performance analysis by test section revealed critical weaknesses: students achieved 67.1% accuracy on recognition items, but only 48.5% on comprehension and 36.5% on production tasks, indicating a significant gap between receptive and productive vocabulary knowledge. Focus group discussions provided qualitative depth to these findings. A substantial majority (89.3%) of focus group participants reported forgetting vocabulary quickly after tests. As one student expressed: "Writing words many times is tiring. I remember them for tests but forget them later." Another student noted: "When teacher uses games, I remember words better. It's fun and I want to learn more."

Students' Interactive Media Preferences

The Interactive Media Preference Survey revealed strong student interest in technology-enhanced learning approaches. Analysis indicated that 68% of students (n = 82) expressed preferences for interactive media. Table 2 presents student preferences for learning material types. Educational games were preferred by 80% of students, followed by interactive media (68.3%), videos and animations (65%), group activities (45%), and textbooks/workbooks (30%).

Table 2
Student Preferences for Learning Material Types (n = 120)

Learning Material Type	Frequency	Percentage
Educational games	96	80.0%
Interactive media	82	68.3%
Video lessons	75	62.5%
Flashcards (digital)	68	56.7%
Traditional textbooks	38	31.7%

Analysis of preferred interactive media features revealed strong preferences for gamification elements. Games and scoring received the highest mean rating (M = 4.68, SD = 0.52), followed by immediate feedback (M = 4.52, SD = 0.61), characters and storytelling (M = 4.45, SD = 0.65), sound and animations (M = 4.38, SD = 0.68), competition with friends (M = 4.25, SD = 0.75), and auto-adjusting difficulty (M = 4.12, SD = 0.78). These findings indicate that students value engaging, responsive, and socially connected learning experiences. Regarding AI feature expectations, students expressed strong interest in AI capabilities that support personalized learning. The majority (85%) wanted AI to recommend vocabulary suited to their level, 80% desired AI assistance with pronunciation practice, 70% valued AI-generated learning progress summaries, and 65% were interested in AI-created exercises.

Teacher Perceptions and Concerns

Semi-structured interviews with 10 English teachers revealed important insights regarding current teaching practices and attitudes toward technology integration. Table 3 presents teachers' current vocabulary teaching methods. Analysis indicated that all teachers (100%) currently employ repetition and memorization methods, 90% use translation approaches, 80% assign worksheets, and 70% use flashcards. However, only 30% reported using educational software or applications in their instruction.

Table 3
Teachers' Current Vocabulary Teaching Methods (n = 10)

Teaching Method	Frequency	Percentage
Repetition and memorization	10	100%
Translation method (Thai-English)	9	90%
Picture flashcards	8	80%
Games and activities	5	50%
Educational software/apps	3	30%

A substantial majority of teachers (80%, n = 8) acknowledged limitations of traditional teaching methods. As one teacher explained: "Traditional methods like repetition work for short-term memory, but students often forget vocabulary within weeks. We need more engaging approaches." Teachers expressed strong recognition of AI and interactive media

potential. Nine teachers (90%) agreed that AI could help personalize learning, all ten (100%) believed interactive media increases engagement, 90% thought technology could improve retention, and 80% saw potential for AI to reduce assessment workload. However, teachers also expressed concerns: limited budget (80%), insufficient training (70%), lack of technological infrastructure (60%), internet connectivity issues (60%), and screen time concerns (50%).

Technological Infrastructure and AI Features Priority

The technology infrastructure assessment revealed considerable variation across the four participating schools. Computer labs ranged from 15 to 25 units, tablet availability varied from 0 to 15 devices, internet speeds ranged from 20 to 100 Mbps, and smart classrooms numbered between 1 and 4 per school. These disparities highlight the need for technology solutions that can function effectively across varying infrastructure conditions. Teacher digital readiness assessment indicated moderate overall readiness (M = 3.12, SD = 0.68). Teachers reported high basic computer skills (M = 3.80, SD = 0.63) but lower confidence in using educational apps (M = 3.20, SD = 0.79), technology-enhanced teaching experience (M = 2.90, SD = 0.88), and understanding of AI in education (M = 2.60, SD = 0.97). In contrast, student digital literacy assessment revealed high overall proficiency (M = 3.80, SD = 0.65), with 75% achieving proficient (51.7%) or advanced (23.3%) levels.

The AI Features Priority Assessment captured both student and teacher perspectives on desired AI capabilities. Table 4 presents the priorities from both perspectives. Students prioritized gamification with adaptive AI (M = 4.72, SD = 0.48), virtual conversation partners (M = 4.58, SD = 0.55), speech recognition (M = 4.45, SD = 0.62), personalized recommendations (M = 4.32, SD = 0.68), and learning progress dashboards (M = 4.15, SD = 0.72). Teachers prioritized learning analytics dashboards (M = 4.80, SD = 0.42), automated assessment (M = 4.70, SD = 0.48), adaptive learning paths (M = 4.50, SD = 0.53), smart content generation (M = 4.40, SD = 0.52), and personalized recommendations (M = 4.30, SD = 0.67). These findings reveal complementary perspectives: students value engaging, interactive features while teachers prioritize tools that support instruction and assessment.

Table 4
AI Feature Priorities: Student and Teacher Perspectives

AI Feature	Student Mean	Student Rank	Teacher Mean	Teacher Rank
Gamification with adaptive difficulty	4.72	1	4.30	3
Learning analytics dashboard	3.95	5	4.80	1
Automated assessment	4.12	4	4.70	2
Virtual conversation partner	4.58	2	4.35	4
Speech recognition for pronunciation	4.48	3	4.50	3

Classroom Observations and Synthesis of Findings

Systematic classroom observations across 12 class periods revealed important patterns in teaching practices and student engagement. Teacher-centered instruction dominated observed

class time (75%), with lecture/explanation (100% of classes, averaging 18 minutes) and repetition/drilling (100% of classes, averaging 12 minutes) as the most common activities. Games and interactive activities were observed in only 33% of classes (averaging 8 minutes), and technology use occurred in just 25% of observations (averaging 10 minutes). Student engagement levels varied dramatically based on activity type. High engagement was observed during only 24% of class time, primarily during games and video activities. Medium engagement characterized 40% of class time during group work activities, while low engagement was observed during 36% of class time, predominantly during lecture and drill activities.

Analysis of 24 existing teaching materials across the four schools revealed significant gaps. While materials scored well on curriculum alignment (M = 4.25, SD = 0.62) and age-appropriateness (M = 3.92, SD = 0.75), they demonstrated critical weaknesses in interactive elements (M = 1.75, SD = 0.92), multimedia components (M = 1.42, SD = 0.78), constructivist approaches (M = 1.85, SD = 0.85), and AI/adaptive features (M = 1.08, SD = 0.28). The parent survey (n = 108) revealed technology access varied by device type: 94.4% of families had smartphones, 66.7% had home internet, 41.7% had tablet devices, and 35.2% had computers or laptops. Parents believed technology could help their children learn better (M = 4.12, SD = 0.72) and strongly desired to be informed about their children's progress (M = 4.45, SD = 0.58).

Discussion

The finding that 75% of students experience vocabulary learning as challenging, with long-term retention confirmed as the most significant difficulty (M = 4.45, SD = 0.69), aligns with and extends previous research on vocabulary retention challenges in EFL contexts. The results corroborate Uchihara et al.'s (2023) meta-analysis findings regarding the prevalence of vocabulary forgetting among second language learners and support Suwimol Tirakanant's (2022) observations about accelerated forgetting rates among Thai students. The substantial gap between recognition (67.1%), comprehension (48.5%), and production (36.5%) performance on the vocabulary pre-test reflects the well-documented phenomenon that receptive vocabulary knowledge develops more readily than productive knowledge (Nation, 2022). Students' reports of quickly forgetting vocabulary after tests despite repetitive practice suggest that current instructional approaches fail to create the deep processing and meaningful engagement necessary for durable memory formation, aligning with Dunlosky et al.'s (2013) research demonstrating that mere repetition is among the least effective learning strategies for long-term retention.

Strong student preferences for educational games (80%) and interactive media (68.3%), combined with high digital literacy levels (75% proficient or advanced), indicate substantial readiness for technology-enhanced learning approaches. These findings align with Zou et al.'s (2019) research demonstrating the effectiveness and appeal of digital game-based vocabulary learning. The particularly high ratings for gamification features (M = 4.68) and immediate feedback (M = 4.52) reflect the importance of engagement and responsiveness in educational technology design, consistent with self-determination theory perspectives on intrinsic motivation (Ryan & Deci, 2020). Students' interest in AI features that support personalized learning (85% wanting level-appropriate recommendations, 80% desiring pronunciation practice support) suggests awareness of the potential for technology to address individual learning needs, supporting arguments that AI-enhanced personalization represents a promising direction for addressing the diverse needs of language learners (Bhutoria, 2022; Wang et al., 2024).

The tension between teachers' recognition of traditional method limitations (80%) and AI potential (90%) on one hand, and their concerns about infrastructure (60%) and training (70%) on the other, highlights the complex landscape of educational technology adoption. This finding echoes Choi et al.'s (2022) research on factors influencing teachers' acceptance of educational AI, which identified perceived usefulness and ease of use as critical determinants of adoption intentions. The finding that only 30% of teachers currently use educational software despite widespread recognition of technology's potential suggests that awareness alone is insufficient for adoption. This implementation gap can be understood through technology acceptance frameworks, which emphasize the roles of facilitating conditions, self-efficacy, and organizational support in technology adoption (Tan et al., 2024). The identified training needs—particularly AI-assisted teaching tools (90%) and creating interactive materials (80%)—provide clear priorities for professional development initiatives.

The significant variation in technological infrastructure across schools—from 0 to 15 tablets and 20 to 100 Mbps internet speeds—has important implications for system design. These disparities, combined with concerns about internet connectivity (60% of teachers), suggest that effective AI-enhanced learning systems must be designed for flexibility and offline functionality. This finding aligns with research by Lin et al. (2024) on the importance of designing inclusive AI technologies that function effectively across diverse learning environments. The analysis of existing teaching materials revealed critical gaps in interactive elements, multimedia components, and adaptive features that technology can address. The nearly complete absence of AI or adaptive features in current materials (M = 1.08) represents both a limitation of current practice and an opportunity for innovation. The high smartphone access rate among families (94.4%) suggests that mobile-friendly design could extend learning opportunities beyond school settings, addressing the limited English exposure that characterizes the Thai EFL context.

The convergent findings from multiple instruments provide clear guidance for designing Interactive Media in an AI-Enhanced Constructivist Learning Environment. The system should incorporate gamification elements with adaptive difficulty, immediate feedback mechanisms, engaging characters and narratives, and social/competitive features. AI capabilities should prioritize personalized vocabulary recommendations, pronunciation practice with speech recognition, progress tracking and analytics, and adaptive learning paths that respond to individual performance and preferences. From a constructivist perspective, the system should provide opportunities for active exploration, meaningful contextualization of vocabulary, collaborative learning activities, and learner agency in directing their learning. The design should address retention challenges through spaced repetition algorithms informed by cognitive science research, multimodal presentation drawing on dual coding theory (Paivio, 1991) and working memory models (Baddeley, 2012), and productive practice opportunities that require vocabulary application rather than mere recognition.

Technical design should accommodate varying infrastructure conditions through offline functionality and mobile compatibility while providing teacher dashboards for monitoring progress and informing instruction. Implementation support mechanisms are essential given the identified training needs and infrastructure concerns. The system should include comprehensive teacher professional development materials: video tutorials demonstrating key features, detailed user guides with troubleshooting information, sample lesson plans integrating the system into instruction, and ongoing technical support channels. Teachers' moderate overall digital readiness (M = 3.12) and limited AI understanding (M = 2.60) necessitate professional

development that builds both technical skills and pedagogical understanding of effective technology integration.

Several limitations should be considered when interpreting these findings. First, the study was conducted in four schools within a single province, which may limit generalizability to other regions of Thailand or other EFL contexts. Second, the cross-sectional design captures needs and preferences at a single point in time; longitudinal research would provide insight into how these factors evolve. Third, self-report measures may be subject to social desirability bias, particularly regarding student preferences for technology. Fourth, the study focused on fifth-grade students, and findings may not generalize to other age groups. Despite these limitations, the mixed-methods approach with data triangulation across multiple instruments strengthens confidence in the key findings.

Conclusion

This study investigated the needs and potential of interactive media in an AI-enhanced constructivist learning environment for English vocabulary acquisition among elementary school students in Thailand. Through comprehensive data collection from 120 students, 10 teachers, 108 parents, and systematic observation and analysis, the research revealed substantial vocabulary learning challenges, strong student preferences for technology-enhanced approaches, teacher recognition of innovation potential alongside implementation concerns, and varying but generally adequate infrastructure for technology integration.

Key findings indicate that vocabulary retention represents the most significant learning challenge, with 75% of students reporting difficulties and 55% performing below satisfactory levels on baseline assessment. Students demonstrate strong preferences for interactive, gamified learning approaches (68% preferring interactive materials) and high digital literacy (75% proficient or advanced). Teachers acknowledge traditional method limitations (80%) and recognize AI potential (90%) but identify training (70%) and infrastructure (60%) as barriers. These findings collectively establish a clear evidence base for developing an AI-enhanced constructivist learning system that addresses identified needs while leveraging available resources and capabilities.

This research contributes to the field in several ways. Theoretically, it extends understanding of vocabulary learning challenges and technology potential in the Thai EFL context, providing context-specific evidence that complements international research. The study demonstrates the value of mixed-methods needs assessment approaches that integrate multiple stakeholder perspectives. Practically, the findings provide evidence-based specifications for designing AI-enhanced vocabulary learning systems, identify priority areas for teacher professional development, and inform policy decisions regarding technology integration in Thai elementary education. Methodologically, the study demonstrates the value of comprehensive mixed-methods needs assessment employing twelve complementary instruments to triangulate findings and provide multifaceted understanding of complex educational challenges.

Based on the findings, several recommendations emerge for future research and educational practice. First, development and evaluation research should design, implement, and assess an AI-enhanced constructivist learning system incorporating the identified features and addressing the documented needs. Second, longitudinal studies should track vocabulary retention and language development over extended periods to assess the durability of learning gains from technology-enhanced instruction. Third, teacher professional development

programs should address identified training needs while building confidence and reducing anxiety about technology integration. Fourth, expanded research across additional regions and grade levels would strengthen generalizability and inform scaled implementation. Fifth, investigations of the specific AI algorithms and adaptive mechanisms that most effectively support vocabulary learning would advance both theoretical understanding and practical design.

In conclusion, this study establishes a foundation for transforming English vocabulary instruction through thoughtfully designed AI-enhanced interactive learning environments. By addressing the documented retention challenges through engaging, personalized, and constructivist approaches, such systems hold potential for improving learning outcomes while maintaining student motivation and supporting teachers in their instructional efforts. The comprehensive needs assessment presented here provides the evidence base necessary for moving from conceptualization to implementation, contributing to the ongoing evolution of technology-enhanced language education.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that no AI or AI-assisted technologies have been used to generate, refine, or correct the content in the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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