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Learner Acceptance of AI-integrated Gamified Learning for Chinese Pronunciation: A Technology Acceptance Model Study

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Abstract

This study investigates learners' acceptance of an AI-integrated gamified learning approach for Chinese pronunciation through the Technology Acceptance Model (TAM). Although artificial intelligence and gamification have been widely reported to enhance learning performance, empirical evidence concerning learners' perceptions and acceptance—particularly in pronunciation-focused digital language learning, remains limited. Understanding learner acceptance is essential for the sustainable implementation of AI-enhanced learning technologies in educational contexts. The study was conducted with lower secondary school students who participated in AI-integrated gamified pronunciation learning activities incorporating gamified quizzes and AI-generated voice support. Learner acceptance was examined using a TAM-based questionnaire comprising four constructs: perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention to use. Data was analyzed using descriptive statistics to examine learners' perceptions across TAM dimensions. The findings indicate high levels of learner acceptance toward the AI-integrated gamified learning approach. Attitude toward using demonstrated the highest mean score, followed by perceived ease of use and perceived usefulness, suggesting that affective engagement and system usability play central roles in shaping acceptance. Learners also expressed positive behavioral intentions to continue using AI-supported gamified learning for pronunciation practice. These findings highlight the importance of learner-centered design in AI-enhanced digital learning environments and support the sustainability and broader application of AI-integrated gamified learning in language education.

Keywords: Learner Acceptance, Technology Acceptance Model, AI-Integrated Learning, Gamified Learning, Chinese Pronunciation

■ Introduction

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Amid accelerating globalization, China's expanding presence across economic, cultural, and educational domains has elevated the strategic value of Chinese language proficiency for international communication and workforce mobility. In the Thai context, long-standing bilateral cooperation with China has reinforced the institutional prioritization of Chinese as a foreign language within formal schooling. This national emphasis is codified in the Basic Education Core Curriculum B.E. 2551, which positions foreign language learning as a core mechanism for strengthening intercultural communicative competence. Within this policy and educational framework, communicative proficiency—particularly skills enabling authentic spoken interaction—has gained increasing instructional prominence. Among the interrelated components of communicative competence, pronunciation represents a critical foundation for intelligible oral expression. This is especially salient in Mandarin Chinese, where tonal distinctions and pinyin articulation operate as phonemic carriers of lexical meaning rather than peripheral phonetic features. Empirical scholarship has consistently shown that pronunciation accuracy supports listening comprehension, speech clarity, and learner self-confidence in tonal language acquisition (Qiao & Zhao, 2023; Tang & Zhao, 2023). However, Thai learners frequently encounter structural phonological challenges stemming from contrasts between Thai and Mandarin sound systems, particularly in tone contour realization and segmental production (Tang, 2023). When such challenges are insufficiently addressed through systematic instruction, learners risk developing entrenched pronunciation errors that resist subsequent correction (Liu, 2023). From the standpoint of second language acquisition theory, sustained exposure to comprehensible auditory input therefore remains indispensable for facilitating phonological development and perceptual attunement (Krashen, 1985).

Extending beyond structural linguistic constraints, classroom-based evidence further indicates that lower secondary learners often experience reduced confidence when producing Mandarin tones and pinyin within connected speech, reflecting both cognitive difficulty and affective hesitation (Chupradit, 2021). These challenges are exacerbated by limited access to stable and repeatable pronunciation exemplars, thereby restricting opportunities for individualized rehearsal and feedback. In response to these pedagogical limitations, contemporary digital learning innovations have introduced new modalities for supporting language acquisition. Technology-enhanced and inquiry-driven learning environments, for example, have been shown to cultivate active engagement and deeper knowledge construction, providing an instructional basis for sustainable digital learning design (Thongkoo et al., 2024). Within such ecosystems, gamified platforms—including Quizizz—enable structured interaction, formative assessment, and immediate feedback, while AI-generated voice systems supply standardized pronunciation input accessible for repeated listening and imitation. Emerging empirical work integrating these technologies demonstrates that AI-integrated gamified learning media can strengthen Chinese pronunciation development through the convergence of interactive participation and high-fidelity synthesized speech (Hu et al., 2026). From a learning engineering perspective, these integrative environments offer value not only as instructional tools but also as scalable infrastructures capable of sustaining learner engagement and adaptive practice over time.

Notwithstanding the expanding evidence base documenting the instructional effectiveness of gamified learning systems and AI-supported language tools, learner acceptance remains a comparatively underexplored determinant of long-term technological adoption. Even when measurable learning improvements are observed, sustained utilization is mediated by learners' perceptions of usability, instructional value, and experiential quality. To examine these perceptual dimensions systematically, the Technology Acceptance Model (TAM), first articulated by Davis (1989), provides a theoretically grounded framework through which acceptance may be analyzed via perceived usefulness and perceived ease of use, alongside their influence on attitude toward using and behavioral intention to use (Venkatesh & Davis, 2000; Venkatesh et al., 2003). Within educational technology research, TAM has been widely operationalized to investigate learners' engagement with digital instructional environments. Empirical findings suggest that TAM constructs effectively capture acceptance dynamics across varied technology-enhanced settings. For example, Thongkoo, Panjaburee, and Daungcharone (2019a) validated TAM within inquiry-oriented learning contexts, while subsequent work (Thongkoo, Panjaburee, & Daungcharone, 2019b) extended its applicability to ubiquitous learning environments. Parallel evidence has been reported in broader digital education ecosystems (Salloum et al., 2022). Nevertheless, investigations examining learner acceptance in pronunciation-centered AI-integrated gamified environments, particularly at the lower secondary level, remain limited. Prior scholarship has predominantly emphasized performance outcomes or system functionality, leaving learners' perceptual responses and sustained usage intentions insufficiently examined. Addressing this gap, the present study investigates learners' acceptance of an AI-integrated gamified learning approach for Chinese pronunciation through the TAM framework, focusing on perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention to use. By situating the inquiry within an authentic lower secondary learning environment, this research seeks to contribute to digital education and learning engineering, particularly with respect to the sustainable design and implementation of AI-enhanced language learning systems.

■ Research Questions

1) What are learners' perceptions of perceived usefulness (PU) and perceived ease of use (PEOU) toward AI-integrated gamified learning for Chinese pronunciation?
2) What are learners' attitudes toward using AI-integrated gamified learning activities for Chinese pronunciation?
3) To what extent do learners demonstrate behavioral intention to continue using AI-integrated gamified learning for Chinese pronunciation?

■ Literature Review

Technology Acceptance Model (TAM) in Educational Technology

The Technology Acceptance Model (TAM) continues to function as one of the most widely utilized theoretical frameworks for explaining users' acceptance of information technology in contemporary educational research. A substantial body of empirical evidence reaffirms that TAM offers a robust explanatory lens for understanding learners' adoption of digital learning systems, particularly through its core constructs of perceived usefulness (PU) and perceived ease of use (PEOU), which act as principal determinants shaping attitude toward using and behavioral intention to use educational technologies (Scherer & Teo, 2019; Al-Emran & Shaalan, 2021). In this context, perceived usefulness denotes learners' beliefs that a technological system enhances academic performance, whereas perceived ease of use reflects the degree to which interaction with the system is perceived as cognitively effortless and operationally manageable. Building upon these foundational constructs, subsequent theoretical extensions and empirical applications have further emphasized the predictive roles of attitude toward using (ATU) and behavioral intention to use (BI) in shaping technology adoption across diverse digital learning environments (Venkatesh et al., 2003; Abdullah et al., 2023). Collectively, these findings indicate that learners demonstrate stronger acceptance and sustained engagement when educational technologies are perceived as instructionally beneficial, technically accessible, and affectively satisfying. Within formal educational contexts, TAM has therefore been extensively applied to investigate learners' acceptance of a wide spectrum of technology-enhanced systems, including e-learning platforms, mobile learning applications, artificial intelligence–supported environments, and inquiry-oriented digital learning ecosystems. Prior empirical investigations have confirmed that TAM-based constructs reliably capture learners' perceptions and acceptance of technology-mediated instructional designs, particularly within flipped classroom and ubiquitous learning settings (Thongkoo, Panjaburee, & Daungcharone, 2019a, 2019b). More recent scholarship continues to corroborate the explanatory strength of PU and PEOU as stable predictors of students' attitudinal and intentional responses toward digital learning technologies, reinforcing TAM's analytical relevance for examining learner acceptance beyond instructional effectiveness alone (Salloum et al., 2022; Huang & Teo, 2024). Consequently, TAM has evolved into a foundational framework not only for interpreting initial technology adoption but also for understanding the longer-term sustainability of digital learning innovations within formal educational systems.

Learner Acceptance and Sustainability in Digital Learning

Learner acceptance constitutes a pivotal determinant of the long-term viability and sustainability of digital learning environments. While instructional technologies may yield positive outcomes in controlled or short-term implementations, their sustained integration within authentic educational settings depends largely on learners' perceptions, attitudes, and willingness to engage over time (Bond et al., 2021; Schindler et al., 2025). Recent scholarship further conceptualizes learner acceptance as a mediating construct linking technological innovation with meaningful educational impact, particularly within learner-centered and technology-enhanced instructional ecosystems. Empirical studies grounded in the Technology Acceptance Model indicate that perceived usefulness exerts a strong influence on learners' attitudinal responses when digital tools are aligned with pedagogical objectives and perceived as supportive of academic performance (Al-Rahmi et al., 2022). In parallel, perceived ease of use has been shown to alleviate cognitive load and facilitate more seamless interaction with digital systems—an effect that is especially consequential for younger learners and individuals with limited prior exposure to advanced educational technologies (Tang et al., 2023). Positive attitudes toward technology use have likewise been associated with heightened motivation, deeper engagement, and stronger intentions for continued use, underscoring the centrality of

affective dimensions within acceptance processes. Within language learning contexts, the significance of learner acceptance becomes even more pronounced, given that language acquisition necessitates sustained practice, iterative exposure, and continuous learner participation. Technologies that fail to secure learner acceptance are therefore unlikely to be utilized consistently, irrespective of their pedagogical affordances (Kohnke et al., 2023). Examining learner acceptance through a TAM-informed analytical lens thus provides critical insight into how digital language learning environments may be designed to foster enduring engagement and support instructional sustainability.

Gamified Learning and Perceived Ease of Use

Gamified learning refers to the integration of game-based elements—such as point systems, performance feedback, progressive challenges, and interactive tasks—into instructional activities to enhance learner engagement and motivation. Within digital learning environments, a growing body of empirical research indicates that gamification promotes active participation, enjoyment, and sustained attentional focus, particularly in learning tasks that require repetition or continuous practice (Zainuddin et al., 2020; Toda et al., 2022). From the perspective of the Technology Acceptance Model, gamified environments are closely aligned with perceived ease of use, as game-oriented interfaces frequently streamline interaction processes and reduce learners' perceived effort in navigating learning systems. Empirical investigations further demonstrate that gamified digital platforms enhance usability through features such as immediate feedback, transparent progress tracking, and intuitive navigation structures, all of which contribute to learners' perceptions that the system is accessible and user-friendly (Sailer & Homner, 2023; Zhang et al., 2024). These affordances not only lower technological entry barriers but also cultivate more favorable attitudes toward the adoption of digital learning tools. In addition, gamification has been consistently associated with heightened learner motivation and engagement—affective variables that play a formative role in shaping attitudes within TAM-based acceptance models (Hamari et al., 2014). Within pronunciation-focused language learning, the relevance of gamification becomes particularly pronounced, as pronunciation training often relies on repetitive drills and corrective feedback that learners may perceive as monotonous in conventional instructional formats. Gamified learning environments can reframe such practice into interactive and cognitively manageable experiences, thereby increasing learners' willingness to engage with digital pronunciation tools. Consequently, gamified learning is posited to exert a positive influence on perceived ease of use as well as on learners' attitudinal dispositions toward AI-integrated pronunciation learning environments.

AI-Generated Voice and Perceived Usefulness in Language Learning

Recent advancements in artificial intelligence have substantially enhanced the capabilities of AI-generated voice technologies, enabling the production of speech that is natural, intelligible, and acoustically consistent across multiple languages. Within educational contexts, these systems have been increasingly adopted to support listening practice, pronunciation modeling, and learner accessibility (Pérez et al., 2021; Sungkur et al., 2025). From the perspective of the Technology Acceptance Model, AI-generated voice technologies are closely associated with perceived usefulness, as they directly facilitate learners' task performance by delivering reliable and repeatable auditory input. Empirical research indicates that high-quality synthesized speech strengthens learners' exposure to accurate pronunciation exemplars and supports repeated listening and imitation without temporal or spatial limitations (Qiao & Zhao, 2023; Dennis, 2024). In pronunciation-focused language learning, such consistent and intelligible input is essential for

developing phonological awareness, tonal precision, and confidence in oral production. When learners recognize that AI-generated voice support enhances the effectiveness of their pronunciation practice, their perceptions of system usefulness increase correspondingly. In addition, AI-generated voice technologies promote more autonomous learning by enabling learners to engage in independent pronunciation rehearsal beyond teacher-provided materials. This flexibility and accessibility further reinforce perceptions that AI-supported learning environments are beneficial and aligned with individual learning needs (Vančová, 2023). Consequently, AI-generated voice support is expected to play a central role in shaping perceived usefulness and, indirectly, learners' attitudes and behavioral intentions toward AI-integrated gamified pronunciation learning environments.

Despite expanding evidence on the instructional effectiveness of gamified learning and AI-supported language technologies, research has primarily emphasized learning outcomes, system performance, and engagement indicators. Learners' acceptance of AI-integrated gamified learning environments remains comparatively underexplored, particularly when examined through the Technology Acceptance Model. This limitation is pronounced in pronunciation-focused language learning, where sustained interaction is essential. Empirical investigations at the lower secondary level are also limited, despite its importance for phonological development and technology adoption (Kohnke et al., 2023; Huang & Teo, 2024). Addressing this gap, the present study examines learner acceptance of AI-integrated gamified learning for Chinese pronunciation through TAM constructs.

■ Research Methodology

Participants

The participants comprised 40 Grade 9 students enrolled in the second semester of the 2025 academic year at a lower secondary school in Chiang Mai Province, Thailand. Purposive sampling was employed to recruit participants who met criteria relevant to the objectives of this study. The selected school granted permission for the researcher to conduct the instructional intervention and collect research data within the classroom setting. The participating class was identified in consultation with the school's Chinese language department and was considered suitable for the implementation of the AI-integrated gamified pronunciation learning activities. The students were regularly enrolled in Chinese as a foreign language course and received weekly Chinese language instruction as part of the school curriculum. Classroom observations conducted prior to the study indicated that many students experienced difficulties in Chinese pronunciation, highlighting the need for additional pronunciation practice within the learning process. In addition, the students had prior experience using digital learning platforms during classroom instruction, which enabled them to engage effectively with the AI-integrated gamified learning activities. All participants took part in the AI-integrated gamified pronunciation learning activities implemented as part of their regular Chinese language instruction, and the study did not aim to compare different instructional approaches but rather to examine learners' perceptions and acceptance of the AI-integrated gamified learning environment. Accordingly, all participants were included in the analysis of learner acceptance based on the Technology Acceptance Model.

Ethical Considerations

This study was conducted in accordance with established research ethics guidelines and received ethical approval from the Chiang Mai University Research Ethics Committee (Approval No. CMUREC 68/296). Permission to conduct the research was obtained from the Chinese language department of the participating school and from the classroom teacher responsible for the course. As the participants were lower secondary school students, informed consent was obtained from both the students and their parents or guardians prior to the study. All participants were informed about the purpose and procedures of the research, and participation was entirely voluntary. Students were also assured that their responses would remain anonymous and be used solely for academic research.

Learning Context

The learning activities were implemented across four lesson units focusing on the topic of Seasons (Units 1–4). Each unit was delivered over a two-hour session, resulting in a total instructional duration of eight hours. The learning environment integrated gamified quiz-based activities administered via Quizizz alongside AI-generated voice support provided by ElevenLabs. The synthesized audio delivered clear and natural pronunciation models, enabling learners to engage in listening and imitation practice during pronunciation-focused tasks. Instructional materials were subsequently reviewed and evaluated by three experts in Chinese language education and educational technology. The evaluation results indicated a high level of instructional quality and appropriateness, reflected in an average rating score of 4.75 out of 5.00 and an item–objective congruence (IOC) value of 1.00.

The instructional activities in this study were implemented within an AI-integrated gamified learning environment designed to support Mandarin pronunciation practice. Prior to each lesson, teachers prepared instructional materials and generated standardized Mandarin pronunciation models using an AI-based text-to-speech system to ensure consistent tonal input. During the learning sessions, students first listened to the AI-generated audio through mobile devices to become familiar with the target sounds. This listening stage was followed by imitation and repeated shadowing practice, allowing learners to reproduce the pronunciation and increase their exposure to Mandarin tonal patterns and pinyin articulation. After the initial listening and imitation activities, students engaged in teacher-assigned gamified exercises delivered through the digital platform, where they completed pronunciation-related tasks embedded in interactive quizzes. The gamified activities incorporated elements such as scoring systems, time-based challenges, and immediate feedback, which encouraged active participation and reinforced correct responses. Through this process, AI-generated pronunciation support and gamified activities interacted within a structured learning sequence consisting of listening, imitation, practice, and feedback stages. The platform also generated performance data that enabled teachers to monitor students' progress and adjust instructional support when necessary. This procedural design enabled students to repeatedly access pronunciation models while actively engaging in gamified tasks, thereby integrating auditory input with interactive practice. A more detailed description of the system design and implementation is reported in Hu et al. (2026).

Research Instrument

To examine learner acceptance, a questionnaire grounded in the Technology Acceptance Model (TAM) was employed as the primary research instrument. The instrument was adapted from established TAM frameworks and prior educational technology research and comprised 18 items distributed across four

constructs: perceived usefulness (PU; 5 items), perceived ease of use (PEOU; 5 items), attitude toward using (ATU; 4 items), and behavioral intention to use (BI; 4 items). All items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Content validity was evaluated by three experts in educational technology and language education, with all items demonstrating an item–objective congruence (IOC) value of 1.00, indicating strong alignment between the questionnaire indicators and the intended TAM constructs.

To further examine the instrument's reliability, internal consistency was assessed using Cronbach's alpha. The analysis indicated acceptable to high levels of reliability across the four constructs. The Cronbach's alpha values were 0.788 for perceived usefulness (PU), 0.800 for perceived ease of use (PEOU), 0.700 for attitude toward using (ATU), and 0.892 for behavioral intention to use (BI). All values met or exceeded the commonly accepted threshold of 0.70, suggesting that the questionnaire demonstrated satisfactory internal consistency for measuring learners' acceptance of the AI-integrated gamified learning environment.

Data Collection and Analysis

Upon completion of the AI-integrated gamified learning activities, the TAM-based questionnaire was administered to all participants. Collected data were analyzed using descriptive statistical techniques, specifically mean and standard deviation, to examine learners' perceptions across the four TAM constructs. The analysis aimed to determine overall levels of learner acceptance while identifying perceptual patterns related to perceived usefulness, perceived ease of use, attitudes toward using, and behavioral intention to use AI-integrated gamified learning for Chinese pronunciation.

Data analysis was conducted using descriptive statistical techniques to examine learners' acceptance of the AI-integrated gamified learning environment. Mean and standard deviation values were calculated for each Technology Acceptance Model construct, including perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention to use. The analysis emphasized interpreting learners' perceptual responses across these dimensions to determine overall acceptance levels and to generate insights into factors influencing their willingness to engage with AI-integrated gamified learning for Chinese pronunciation. No inferential statistical procedures were employed, as the study aimed to investigate learner acceptance rather than to compare instructional outcomes across groups.

Research Design and Procedure

This study employed a descriptive research design grounded in the Technology Acceptance Model (TAM) to examine learners' acceptance of an AI-integrated gamified learning environment for Chinese pronunciation. Rather than comparing instructional effectiveness across groups, the investigation focused on learners' perceptions, attitudes, and behavioral intentions toward AI-supported gamified learning. The research procedure comprised three primary stages, as illustrated in Figure 1. In the first stage, participants engaged in AI-integrated gamified pronunciation learning activities implemented within their regular Chinese language instruction. The intervention was conducted over a four-week period, with two instructional hours per week, resulting in a total of eight hours. The learning environment combined gamified quiz-based activities with AI-generated voice support to facilitate pronunciation practice. In the second stage, following completion of the learning activities, learners were invited to reflect on their learning experiences, after which a TAM-based questionnaire was administered to collect data on perceived usefulness, perceived ease of use, attitudes toward using, and behavioral

intention to use the AI-integrated gamified learning environment. In the final stage, the collected data were analyzed to determine overall levels of learner acceptance and to identify perceptual patterns across TAM constructs. The procedure was designed to capture learner acceptance within an authentic educational context.

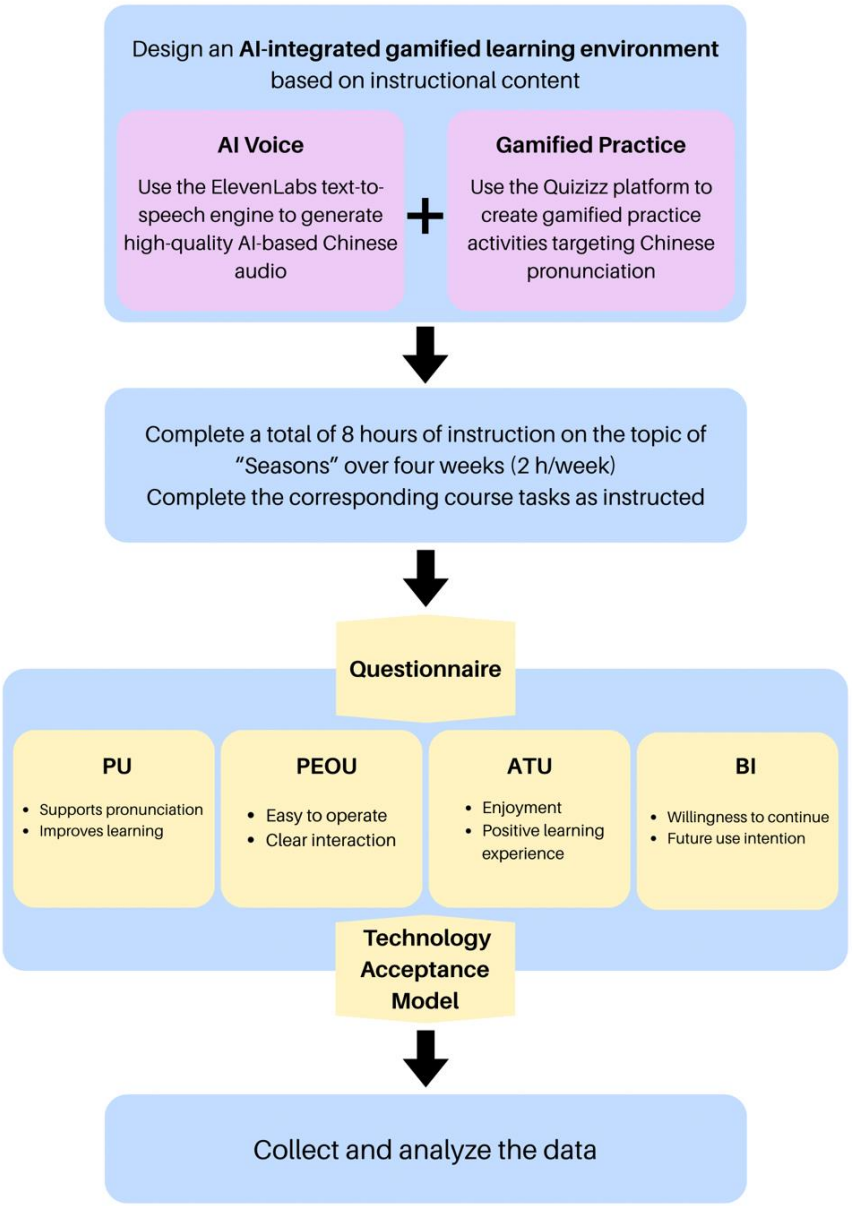


Figure *1.* Technology Acceptance Model (TAM) conceptual framework for AI-integrated gamified Chinese pronunciation learning

■ Results

To facilitate the interpretation of the mean scores obtained from the five-point Likert scale, the following criteria were applied: 1.00–1.49 = strongly disagree, 1.50–2.49 = disagree, 2.50–3.49 = neutral, 3.50–4.49 = agree, and 4.50–5.00 = strongly agree. These interpretation ranges were used to classify the levels of agreement reported in Table 1.

Overview of Learner Acceptance

Learner acceptance of the AI-integrated gamified learning approach for Chinese pronunciation was examined using descriptive statistics grounded in the Technology Acceptance Model (TAM). Mean scores and standard deviations were calculated across four constructs: perceived usefulness (PU), perceived ease of use (PEOU), attitude toward using (ATU), and behavioral intention to use (BI). As presented in Table 1, all constructs recorded mean scores above 4.30 on a five-point Likert scale, indicating a high overall level of learner acceptance toward the AI-integrated gamified learning environment.

Perceived Usefulness of the Learning Environment

Learners' perceptions of the usefulness of the AI-integrated gamified learning approach were similarly positive. Perceived usefulness (PU) yielded a mean score of 4.32 (S.D. = 0.75), indicating that learners generally agreed the learning environment effectively supported their Chinese pronunciation practice. This result suggests that learners recognized the instructional value of integrating AI-generated voice pronunciation models with interactive gamified learning activities, particularly in facilitating pronunciation rehearsal, auditory modeling, and sustained engagement within the digital learning environment.

Perceived Ease of Use and Attitude toward Using

Learners reported highly positive perceptions regarding system usability and engagement within the AI-integrated gamified learning environment. Perceived ease of use (PEOU) demonstrated a high mean score ($\bar{x}$ = 4.43, S.D. = 0.56), indicating that learners found the system convenient and manageable to operate. This suggests that the gamified learning activities and AI-supported features did not create substantial technical or cognitive barriers during use. Attitude toward using (ATU) recorded the highest mean score among the TAM constructs ($\bar{x}$ = 4.51, S.D. = 0.58), reflecting strong positive affective responses toward the learning approach, including enjoyment and interest in engaging with Chinese pronunciation activities through the AI-integrated gamified environment.

Behavioral Intention to Use

Behavioral intention to use (BI) demonstrated a high level of learner acceptance, with a mean score of 4.34 (S.D. = 0.77). This finding indicates that learners expressed a clear willingness to continue using AI-integrated gamified learning activities in future learning contexts. The positive intention to use reflects learners' overall acceptance of the learning environment and suggests the potential sustainability of this instructional approach from a technology acceptance perspective, particularly in supporting continued engagement with digital pronunciation learning.

Table 1.

Mean scores and agreement scale of learners

Evaluation list	$\bar{x}$	S.D	Agreement Scale
Perceived Usefulness: PU	4.32	0.75	Agree
1. The use of AI-generated audio helps me pronounce Chinese more accurately.	4.10	0.79	Agree
2. Quizizz enables me to practice pronunciation more frequently and in a more enjoyable way.	4.30	0.86	Agree
3. This activity format helps me better remember Mandarin tones.	4.40	0.60	Agree
4. The integration of AI voice and Quizizz allows me to learn more efficiently than traditional methods.	4.35	0.75	Agree
5. This technology helps improve my pronunciation learning outcomes.	4.45	0.76	Agree
Perceived Ease of Use: PEOU	4.43	0.56	Agree
1. I can use Quizizz conveniently.	4.50	0.51	Strongly Agree
2. I can easily listen to and understand the AI-generated audio.	4.15	0.67	Agree
3. The procedures of the learning activities are not complicated.	4.45	0.51	Agree
4. I can use the devices and learning materials with minimal assistance.	4.55	0.51	Strongly Agree
5. Overall, this technology is easy to use.	4.50	0.61	Strongly Agree
Attitude Toward Using: ATU	4.51	0.58	Strongly Agree
1. Using AI together with Quizizz is an interesting way to learn.	4.45	0.51	Agree
2. I have a positive attitude toward using this technology.	4.65	0.59	Strongly Agree
3. This technology makes learning Chinese more enjoyable.	4.70	0.57	Strongly Agree
4. I believe this approach is suitable for use in modern classrooms.	4.25	0.64	Agree
Behavioral Intention to Use: BI	4.34	0.77	Agree
1. I would like to continue using AI voice for pronunciation practice.	4.00	0.79	Agree
2. I would like to use Quizizz in other lessons as well.	4.40	0.75	Agree
3. I intend to use this technology to further develop my speaking skills.	4.40	0.75	Agree
4. I would like teachers to continue using this type of learning activity in the future.	4.55	0.76	Strongly Agree
complex	4.40	0.66	Agree

Summary of TAM-Based Results

Taken together, the results illustrated in Figure 2 demonstrate strong learner acceptance of the AI-integrated gamified learning approach across all Technology Acceptance Model dimensions. High levels of perceived ease of use and positive attitudes toward using were accompanied by favorable perceptions of usefulness and a clear behavioral intention to continue using the learning environment. These findings

support the feasibility of AI-integrated gamified learning for Chinese pronunciation from a technology acceptance perspective.

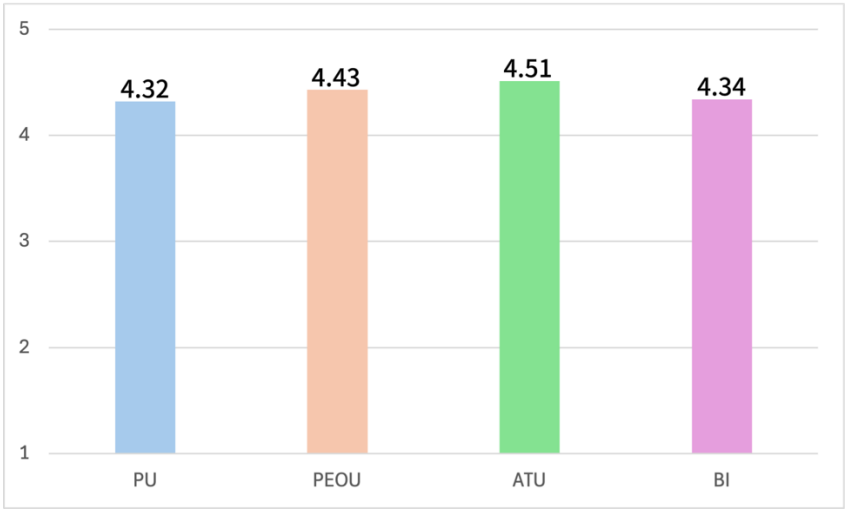


Figure *2.* Learner Acceptance Across TAM Constructs

■ Discussion

The findings indicate a high level of learner acceptance toward the AI-integrated gamified learning approach for Chinese pronunciation. From a Technology Acceptance Model (TAM) perspective, learners expressed positive perceptions across perceived ease of use, perceived usefulness, attitude toward using, and behavioral intention to use, suggesting that the integration of gamified quiz-based activities via Quizizz with AI-generated voice support from ElevenLabs was well received by lower secondary learners. Strong ratings for perceived ease of use suggest that the learning environment was intuitive and convenient to operate. The gamified structure of Quizizz, including interactive tasks and immediate feedback, appears to have reduced usability barriers and supported learner engagement, consistent with studies showing that gamified platforms enhance interactional ease and user experience in technology-enhanced learning environments (Khunaporn Meejaroen & Ubonwan Songsom, 2021; Margallo et al., 2023). Learners also demonstrated positive attitudes toward using the system, reflecting enjoyment and interest in participating in pronunciation learning activities. This finding aligns with prior research highlighting the motivational affordances of gamification and its capacity to foster favorable attitudes toward digital learning technologies, particularly in repetitive practice contexts (Zainuddin et al., 2020; Sailer & Homner, 2023).

In terms of perceived usefulness, learners regarded the learning environment as beneficial for supporting Chinese pronunciation development. The AI-generated voice provided consistent and intelligible pronunciation models that were perceived as valuable for listening and imitation, corresponding with research indicating that AI voice technologies facilitate spoken-language acquisition through reliable auditory input and flexible practice opportunities (Pérez et al., 2021; Liu, 2023). Learners likewise reported strong behavioral intentions to continue using the AI-integrated gamified approach, suggesting that positive perceptions of usability, instructional value, and learning

experience collectively reinforced their willingness for sustained engagement. This pattern aligns with TAM-based scholarship emphasizing the combined influence of cognitive and affective determinants on technology adoption (Salloum et al., 2022; Al-Emran & Shaalan, 2021). Overall, learner acceptance appears to be shaped by system usability, affective engagement, and perceived instructional value, reinforcing the applicability of TAM for examining acceptance within AI-enhanced pronunciation learning environments.

Although the overall perceived ease of use was high (M = 4.43), the item “I can easily listen to and understand the AI-generated audio” recorded a slightly lower mean score (M = 4.15). This pattern suggests that the perceived difficulty may relate more to the learning task than to the system's usability. While the interface and navigation of the gamified platform were considered easy to operate, processing and distinguishing Mandarin pronunciations require greater cognitive effort. For Thai learners in particular, tonal contrasts and pinyin articulation often present challenges due to differences between Thai and Mandarin phonological systems. In addition, students may be more familiar with the pronunciation patterns of local teachers, which sometimes include slight accent variations, whereas AI-generated speech typically delivers clearer, more standardized pronunciation. Adapting to this more standardized input may therefore require additional listening exposure and practice. Nevertheless, the mean score remains within the “agree” range, indicating that learners generally perceived the AI-generated audio as understandable, although somewhat more demanding than other aspects of system interaction.

■ Limitations and Recommendations

This study employed a descriptive research design with a relatively small sample drawn from a single educational context, which may limit the generalizability of the findings. The implementation also relied on the accuracy of AI-generated voice output, requiring teachers to verify pronunciation quality prior to classroom use. In addition, learner engagement during technology-enhanced activities depended on teachers’ instructional guidance and supervision of students’ device usage. Accordingly, teachers intending to integrate gamified quiz-based learning with AI-generated audio are advised to ensure the accuracy and appropriateness of AI voice output and to provide continuous instructional support and classroom management during learning activities. Future research may extend this approach to other language skills, such as vocabulary acquisition or listening comprehension, and employ larger samples, longer implementation periods, and more diverse educational contexts to further examine the sustainability of learner acceptance and its relationship with learning outcomes

Although AI-generated voices provide stable, clear, and repeatable pronunciation models that support listening and imitation practice, they are intended to serve as a supplementary learning resource rather than a replacement for the teacher. The AI-integrated approach is designed to support teachers by providing consistent pronunciation input and enabling repeated practice opportunities, while teachers continue to play a crucial role in guiding pronunciation awareness, providing contextual explanations, and supporting learners’ communicative use of language.

Conclusion

This study examined learner acceptance of an AI-integrated gamified learning approach for Chinese pronunciation through the Technology Acceptance Model. The findings indicate positive learner perceptions across all TAM constructs, including perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention to use, suggesting that the integration of AI-generated voice support with gamified learning activities was viewed as accessible, engaging, and instructionally beneficial. Rather than emphasizing learning effectiveness, this study contributes to digital education and learning engineering by foregrounding learner acceptance as a critical factor in the sustainable implementation of AI-enhanced language learning environments. The results align with existing scholarship on gamification, AI voice technologies, and TAM-based acceptance, reinforcing the importance of learner-centered design in technology-supported language education. Overall, AI-integrated gamified learning represents a promising and well-accepted approach for supporting Chinese pronunciation practice at the lower secondary level. Future research should extend this line of inquiry across varied educational contexts and further examine how learner acceptance shapes long-term adoption and instructional sustainability.

References

Abdullah, H., Sahudin, Z., Bahrudin, N. Z., Bujang, I., & Khalid, K. (2023). Determinants of educational technology acceptance: An integration of TAM and UTAUT. Asian Journal of University Education (AJUE), 19(4), 638–650.

Al-Emran, M., & Shaalan, K. (Eds.). (2021). Recent advances in technology acceptance models and theories. Springer.

Al-Maroof, R. S., Alnazzawi, N., Akour, I., Ayoubi, K., Alhumaid, K., Nasser, N. M., ... & Salloum, S. (2022). Students' perception towards using electronic feedback after the pandemic: Post-acceptance study. International Journal of Data & Network Science, 6(4).

Al-Rahmi, A. M., Shamsuddin, A., Wahab, E., Al-Rahmi, W. M., Alismaiel, O. A., & Crawford, J. (2022). Social media usage and acceptance in higher education: A structural equation model. Frontiers in Education, 7, Article 964456.

Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. International Journal of Educational Technology in Higher Education, 18, 50.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). Technology acceptance model. Management Science, 35(8), 982–1003.

Dennis, N. K. (2024). Using AI-powered speech recognition technology to improve English pronunciation and speaking skills. IAFOR Journal of Education, 12(2), 107–126.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? A literature review of empirical studies on gamification. Proceedings of the 47th Hawaii International Conference on System Sciences, 3025–3034.

Hu, Z., Thongkoo, K., & Daungcharone, K. (2026). AI-integrated gamified learning media for enhancing Chinese pronunciation: A design and implementation study. In Proceedings of the 11th International Conference

on Digital Arts, Media and Technology (DAMT) and the 9th ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (NCON).

Huang, D.-H., & Teo, T. (2024). Innovative interactive instruction to enhance learning behaviors. Journal of Innovation & Knowledge.

Khunaporn Meejaroen, & Ubonwan Songsom. (2021). Effects of gamified online quizzes on students' engagement and perceived ease of use in technology-enhanced learning environments. Journal of Education and Learning, 10(3), 45–54.

Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). Exploring generative artificial intelligence preparedness among university language instructors: Attitudes, intentions, and professional development needs. Computers and Artificial Intelligence for Education, 1, Article 100156.

Krashen, S. (1985). The input hypothesis: Issues and implications. Longman.

Liu, L., Li, W., Morris, S., & Zhuang, M. (2023). Knowledge-based features for speech analysis and classification: Pronunciation diagnoses. Electronics, 12(9), 2055.

Margallo, A. M., Esteban, R. M., & Gómez, L. S. (2023). Gamified digital platforms and user experience in higher education: Examining usability, engagement, and perceived ease of use. Computers & Education: Artificial Intelligence, 4, 100123.

Pagels, L., Schindler, O., & Luedtke, K. (2025). Overview of styles, content, learning effects and attitudes of students towards digitally enhanced physiotherapy education: A scoping review. BMC Medical Education, 25, Article 176.

Pérez, A., Diaz-Munio, G. G., Gimenez, A., Silvestre-Cerda, J. A., Sanchis, A., Civera, J., ... & Juan, A. (2021). Towards cross-lingual voice cloning in higher education. Engineering Applications of Artificial Intelligence, 105, 104413.

Qiao, H., & Zhao, A. (2023). Artificial intelligence-based language learning: Illuminating the impact on speaking skills and self-regulation in Chinese EFL context. Frontiers in Psychology, 14, 1255594.

Rodrigues, L. R., Pereira, F. D., Toda, A. M., Palomino, P. T., Pessoa, M., Carvalho, L. S. G., ... & Isotani, S. (2022). Gamification suffers from the novelty effect but benefits from the familiarization effect: Longitudinal evidence on gamification's impact. International Journal of Educational Technology in Higher Education, 19(1).

Sailer, M., & Homner, L. (2023). The gamification of learning: A meta-analysis. Educational Psychology Review, 35(1), 77–112.

Salloum, S. A., Al-Emran, M., Shaalan, K., & Habes, M. (2022). What impacts the acceptance of e-learning through social media? In Studies in Systems, Decision and Control (Vol. 335, pp. 419–431). Springer.

Scherer, R., & Teo, T. (2019). Unpacking teachers' intentions to integrate technology: A meta-analysis. Educational Research Review, 27, 90–109.

Sungkur, R. K., & Shibdeen, N. (2025). Pronunciation trainer for second language learning using generative AI. International Journal of Educational Technology in Higher Education, 22, Article 64.

Tang, Q., & Zhao, M. (2023). A study of tone acquisition errors and teaching strategies for beginner-level Thai students learning Mandarin Chinese (Doctoral dissertation, Huachiew Chalermprakiet University). Huachiew Chalermprakiet University Repository.

Tang, X., Mohamed Zainal, S. R. B., & Li, Q. (2023). Multimedia use and its impact on the effectiveness of educators: A technology acceptance model perspective. Humanities and Social Sciences Communications, 10, Article 923.

Thiti Kant Chupradit. (2021). Problems in the pronunciation of consonants, vowels, and tones in Standard Chinese and factors affecting pronunciation of students in the Chinese language program at Ramkhamhaeng University Demonstration School (Secondary level). In Proceedings of the National & International Conference (Vol. 12, No. 1, p. 518). Suan Sunandha Rajabhat University.

Thongkoo, K., Panjaburee, P., & Daungcharone, K. (2019a). A development of ubiquitous learning support system based on an enhanced inquiry-based learning approach. International Journal of Mobile Learning and Organisation, 13(2), 129–147.

Thongkoo, K., Panjaburee, P., & Daungcharone, K. (2019b). Integrating inquiry learning and knowledge management into a flipped classroom to improve students' web programming performance in higher education. Knowledge Management & E-Learning, 11(3), 304–324.

Thongkoo, K., Daungcharone, K., & Panjaburee, P. (2024). Effects of collaborative inquiry-based online approach in Thai university students' computing program. International Journal of Information and Education Technology, 14(2).

Vančová, H. (2023). AI and AI-powered tools for pronunciation training. Journal of Language and Cultural Education, 11(3), 1–15.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science, 46(2), 186–204.

Venkatesh, V., Morris, M. G., Davis, F. D., & Davis, G. B. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425–478.

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. Educational Research Review, 30, 100326.

Zhang, W., Ghanbaripour, A., & Watanabe, T. (2024, March). Explore students' perceptions of gamification technology in higher education. In The Asian Conference on Education & International Development (ACEID 2024) (pp. 178–178).