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Evaluating Digital Games for Chinese Vocabulary Learning from Expert and Learner Perspectives

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Abstract

This study examined the pedagogical potential of existing digital games and a developed prototype for Chinese vocabulary learning through a two-stage evaluative investigation. Recognizing vocabulary acquisition as a central yet challenging component of Chinese as a foreign language, the research first analyzed the strengths and weaknesses of widely used digital tools and games designed for vocabulary learning. Ten Chinese language learning games were systematically reviewed using defined evaluation criteria, including content coverage, design attractiveness, reward and feedback systems, and accessibility considerations. The findings revealed notable pedagogical affordances, particularly in contextualized learning and motivational game mechanics, alongside limitations related to usability and technical constraints. Building on these insights, a prototype digital game was developed and evaluated based on feedback from Chinese language teaching experts and beginner learners. Using questionnaire surveys and open-ended responses, the evaluation focused on content appropriateness, learning motivation, and usability. Descriptive statistical analysis and thematic synthesis indicated consistently positive perceptions from both groups while identifying areas for refinement. The study provides empirical evidence to inform the evaluation and design of digital game-based vocabulary learning tools in Chinese language education contexts.

Keywords: Digital game-based learning, Chinese vocabulary learning, educational game evaluation, expert and learner feedback

■ Introduction

Vocabulary constitutes the foundational building blocks of language and represents the most basic structural unit of sentence construction (Liu, 2000). From a second language acquisition perspective,

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vocabulary learning is widely recognized as both one of the most demanding aspects of language learning and its central component, forming a core task for second language learners (Zhang, 2006). Compared with relatively finite phonological and grammatical systems, Chinese vocabulary is characterized by its extensive scope, semantic richness, and multidimensional forms of expression; consequently, vocabulary acquisition has long been identified as a primary learning barrier for beginners of Chinese (Sun, 2022). As vocabulary learning is inherently gradual and cumulative, effective acquisition requires repeated exposure and meaningful engagement to consolidate comprehension and memory (Schmidt, 2008). Accordingly, vocabulary instruction should incorporate engagement-oriented strategies to reduce reliance on rote memorization and improve learning efficiency (Yang, 2025).

With the rapid advancement of educational technology, digital games have been increasingly integrated into teaching and learning practices, and their use in language education has been shown to stimulate learner interest and motivation (Chen, 2021). Empirical studies indicate that digital games can enrich learning enjoyment and classroom interaction, increase learner participation and opportunities for oral practice, and thereby contribute to improved learning outcomes (Zhao, 2020). Within Chinese language education, Digital Game-Based Vocabulary Learning (DGBVL) provides a pedagogically promising approach by presenting vocabulary in contextualized and immersive environments, supporting language development through interaction and experiential engagement (Wu, 2018). Through narrative structures and game mechanics, game-based learning can sustain curiosity and engagement, which may facilitate vocabulary acquisition and retention (Shu, 2019; Zhang, 2023).

A wide range of digital games and platforms are currently employed in Chinese language learning, including Second Life, Sifteo Cube games, augmented reality applications, virtual reality environments, and self-developed platforms (Yuan, 2021; Rosalin & Ying, 2024). Classroom response and vocabulary tools such as Kahoot! and Quizlet have also been adopted to support Chinese instruction (Gao, 2019; Zhao, 2020).

Although the application of digital games in Chinese vocabulary teaching has received increasing attention, several gaps remain in the existing research on Digital Game-Based Language Learning (DGBLL). Previous studies have primarily focused on university-level learners and have largely emphasized long-term learning outcomes, while systematic evaluations of digital vocabulary learning tools remain limited. There is still a lack of comprehensive analysis that integrates both expert pedagogical perspectives and learners' experiential feedback (Hong, 2018; Vnucko, 2023; Yuan, 2021). To address this gap, the present study developed a Chinese vocabulary learning game prototype, Color Master (CM), and established a structured evaluation framework. Using a mixed-method approach combining questionnaire surveys and qualitative interviews, the study evaluates the prototype from the dual perspectives of Chinese language teaching experts and junior high school learners across three key dimensions: content appropriateness, learning motivation, and usability. The findings aim to provide empirical evidence and practical insights for the design, evaluation, and optimization of digital games for Chinese vocabulary learning.

■ Literature Reviews

Digital Game-Based Learning for Vocabulary Acquisition

Digital games in language learning have gained increasing attention as technology continues to reshape educational practices. Digital games refer to games played on electronic devices such as computers, tablets, or mobile platforms (Anastassiya, 2015). Within educational contexts, digital game-based learning integrates instructional content with game mechanics, employing digital platforms as interactive environments through which specific knowledge and skills can be developed (Marc, 2003). The rapid proliferation of mobile technologies has created expanded opportunities for language educators to design immersive and meaningful learning experiences (Julie, 2018). From a constructivist perspective, learning occurs as individuals actively construct knowledge by adjusting cognitive structures through interaction with their environment (Piaget, 1970). Meaningful game environments provide opportunities for exploration, hypothesis testing, and experiential construction of knowledge (Chiu, 2012). Moreover, digital games can reduce learner anxiety by enabling language practice within relaxed and engaging settings that differ from traditional classroom environments (Zheng, 2015). Empirical evidence suggests that digital games hold substantial potential in language education, particularly in enhancing vocabulary acquisition and learning performance (Ovilia, 2017; Wu, 2025).

Regarding vocabulary learning specifically, digital games are widely recognized for their motivational and cognitive benefits. Their popularity spans age groups and educational domains, including foreign language learning contexts (Vnucko, 2023). By creating engaging and interactive environments, digital games support learners in memorizing, recognizing, and comprehending new vocabulary (Wu, 2025). Gamified features may also reduce learners' anxiety about making mistakes, thereby facilitating vocabulary retention and strengthening learning motivation (Vnucko, 2023). Nevertheless, the effectiveness of game-based vocabulary learning is not universally consistent. While many studies report positive learning outcomes, others indicate that educational games do not always produce significant gains (Wang, 2019). Several challenges have been identified. Not all digital games align with curricular objectives, requiring careful instructional selection and design (Nihayatul, 2022). Learners' responses to gamification may also vary; some experience heightened engagement, whereas others encounter confusion or frustration. Additionally, competitive game elements may trigger emotional reactions that influence learning experiences (Zhao, 2020). From a technological standpoint, barriers such as unstable internet connectivity and limited device access further constrain implementation (Nihayatul, 2022).

Evaluation Dimensions of Educational Digital Games

Determining "what to evaluate" constitutes a central concern in educational game research (Wang, 2019). Scholars have proposed diverse evaluation frameworks to assess the educational effectiveness and design quality of digital games across subject domains. For example, Fan and Cui (2008) synthesized existing evaluation scales to develop a rubric encompassing gameplay, educational value, and technical quality, supported by multiple sub-indicators such as scenario design and contextual richness. Similarly, Liu (2017)

established a science-based educational game evaluation framework grounded in expert assessment and learner feedback. This model includes three primary indicators—learning design, game design, and software development—supported by multiple secondary and tertiary indicators. Building upon these established frameworks, the present study evaluates digital games for Chinese vocabulary learning across three key dimensions: content appropriateness, learning motivation, and usability.

Content appropriateness represents the foundational dimension in educational game evaluation. Educational games must ensure the accuracy, validity, and logical coherence of learning content. Content design should align with learners' cognitive abilities and developmental characteristics while incorporating adaptive learning structures that preserve educational integrity. Clear instructional objectives must also be embedded to ensure alignment between gameplay experiences and intended learning outcomes (Liu, 2017; Shen, 2014; Zhou, 2015). Accordingly, this study conceptualizes content appropriateness through three interrelated aspects: content accuracy and coherence, learner adaptability, and alignment between learning objectives and gameplay outcomes.

Learning motivation constitutes another critical evaluative dimension. Early motivational theories emphasized behavioral reinforcement through rewards and external stimuli (Skinner, 1953). In vocabulary learning contexts, intrinsic motivation plays a particularly important role, as deeper cognitive processing supports long-term retention (Deci, 1985). To examine motivational responses, this study adopts the Language Learning Orientations Scale (LLOS) developed by Noels et al. (2000). Grounded in Self-Determination Theory, the scale measures multiple motivational orientations among language learners and has demonstrated strong reliability and validity. It encompasses five dimensions: Intrinsic Motivation, Introjected Regulation, Identified Regulation, External Regulation, and Amotivation.

Usability represents the third dimension of evaluation, focusing on the functional and experiential quality of educational games. Usability significantly influences both learning effectiveness and user satisfaction (Xue, 2019). In educational contexts, insufficient gameplay engagement or excessive complexity may undermine instructional outcomes. Well-designed systems enhance user experience through intuitive interfaces, operational efficiency, technical stability, and appropriate system requirements (Fan, 2018; Zhou, 2015). In this study, usability is examined across three aspects: playability, artistic quality, and technical proficiency.

■ Methods

Research Design

phase evaluation design to examine digital games for Chinese vocabulary -This study adopted a two 1 phase ,1 As illustrated in Figure .learning and to evaluate the effectiveness of a developed prototype involved a systematic analysis of existing Chinese vocabulary learning games to identify their pedagogical Findings from this phase informed the .across key evaluative dimensions strengths and design limitations .(CM) Color Master ,design and development of the prototype game

The developed game was assessed through playtesting .focused on prototype evaluation 2 Phase The .with Chinese language teaching experts and beginner learners using questionnaires and interviews This .and usability ,learning motivation ,content appropriateness :evaluation examined three dimensions phase design enabled an integrated investigation linking existing game analysis with empirical prototype -two .validation

Phase 1: Analysis of Existing Digital Games

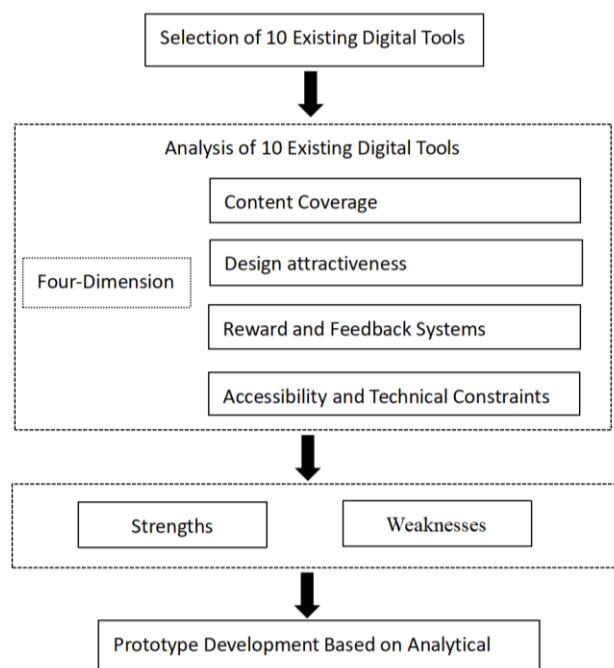


Figure 1. Research Design Framework for Phase 1

1) Selection of digital games

Following the research recommendations of Kirschner and Van Myer-Bor (2013), who suggested that analyzing 10–15 cases is sufficient to capture major research trends while maintaining analytical focus, this study adopted a four-stage screening process to identify representative digital games for Chinese vocabulary learning. The selection procedure consisted of platform identification, keyword retrieval, screening and ranking, and verification. The primary selection criteria were user base and activity level in order to ensure that the selected applications represent widely used and influential digital learning tools.

First, three major software distribution platforms—App Store, Steam, and Google Play—were selected as the primary sources for identifying candidate applications. These platforms were chosen due to their broad user coverage, standardized statistical information, and relatively high transparency in reporting user engagement data, which helps reduce potential bias from manipulated download counts or ratings during sample identification (Abramovich et al., 2013).

Second, keyword searches were conducted using the terms "Chinese learning" and "Chinese games." The search functions and classification systems of these platforms facilitate efficient identification of relevant applications and are consistent with commonly adopted strategies in educational game research

(Yusri, 2025). Applications unrelated to digital games, such as Chinese dictionaries or general language reference tools, were excluded from the screening process.

Third, the identified applications were screened and ranked according to indicators of user engagement and popularity. In educational game research, selecting widely used applications helps improve the representativeness of the sample and reduces potential bias caused by niche or inactive products (Wouters & van Oostendorp, 2013). Games with higher levels of user activity and engagement were therefore prioritized for inclusion.

Finally, the shortlisted applications were verified through manual review and functional testing to ensure their relevance and usability. Non-functional applications or tools that did not meet the study criteria were excluded. Based on this procedure, ten digital games were selected for analysis: Noun Town, Lingotopia, Learn Chinese HSK, Hero Pro, Chinese Vocabulary, Go Play Chinese, Hello Chinese, Chinese Skill, Drops, and Super Chinese. These games collectively represent major design approaches and functional characteristics of contemporary Chinese vocabulary learning applications.

2) Analysis criteria

Based on established perspectives from Chinese language pedagogy, educational game design, and motivation theory, this study developed an analytical framework consisting of four evaluation dimensions: content coverage, design attractiveness, reward and feedback systems, and accessibility with technical constraints.

The content coverage dimension evaluates the breadth and structural completeness of Chinese language knowledge embedded in digital learning games. This includes coverage of four core knowledge components—phonetics, vocabulary, grammar, and Chinese characters—as well as the four language skills of listening, speaking, reading, and writing. This dimension aligns with the framework outlined in the International Chinese Language Teaching General Curriculum Outline (2015), which defines these knowledge and skill categories as the fundamental structure of Chinese language instruction. In addition, Xu (2014) emphasized that "learning opportunities" should be a key criterion in evaluating Chinese educational games, highlighting the importance of comprehensive coverage of linguistic knowledge and language skills.

The design attractiveness dimension focuses on the visual and interactive qualities of the game interface, including interface layout, color schemes, usability clarity, and the integration of gamified interaction elements such as role-playing and challenge-based tasks. According to Csikszentmihalyi's (1990) flow theory, learners are more likely to achieve immersive engagement when clear goals, immediate feedback, and a balance between challenge and skill are present. Effective visual and interaction design therefore plays an important role in supporting immersion and sustaining learner engagement.

The reward and feedback systems dimension examines the motivational mechanisms embedded in the game environment, including reward structures such as points, badges, and leaderboards, as well as immediate feedback features such as corrective responses, sound effects, and visual cues. Garris (2002) identified goals and feedback as essential components in educational game models, arguing that effective

feedback mechanisms are critical for linking gameplay experiences with meaningful learning outcomes.

Finally, the accessibility and technical constraints dimension evaluates practical factors influencing the usability and adoption of digital learning tools, including platform compatibility (e.g., iOS, Android, and PC), device requirements, and pricing models such as free access or subscription barriers. The UNESCO Guidelines on Educational Technology Application highlight accessibility as a fundamental requirement for equitable access to digital learning resources. Similarly, Hung et al. (2018) identified platform compatibility and pricing structures as key external factors affecting learners' adoption of mobile language learning games.

Phase 2: Prototype Evaluation

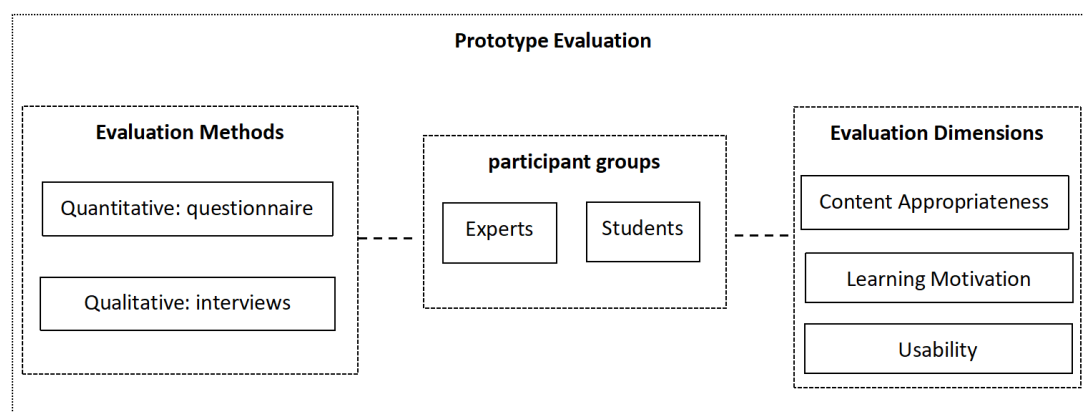


Figure 2. Research Design Framework for Phase 2

Based on insights derived from Phase 1, the prototype game Color Master (CM) was designed by integrating effective design elements while addressing identified limitations. As shown in Figure 2, the prototype was subsequently evaluated from dual perspectives: Chinese language teaching experts and beginner learners.

Participants

Participant selection followed established usability and pilot evaluation guidelines. Nielsen's heuristic evaluation model suggests that three to five experts are sufficient to identify major usability issues in early-stage prototypes. Wang and Hannafin (2005) similarly support small samples in design-stage evaluations. Creswell (2014) recommends 15–30 participants for pilot testing involving descriptive statistical analysis.

Accordingly, this study involved five Chinese language teaching experts and twenty-three beginner Chinese learners. All experts are specialized in Teaching Chinese as a Foreign Language and possessed digital literacy competencies. Student participants were Grade 8 learners from a secondary school in Chiang Mai, Thailand, who participated in prototype testing activities.

Research instruments

Two instruments were employed: a structured questionnaire and open-ended interviews.

1) Questionnaire

The questionnaire was constructed across three evaluative dimensions: content appropriateness, learning motivation, and usability. A five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) was used to capture participant perceptions.

To ensure instrument rigor, a multi-stage validation process was conducted. Item construction was informed by established educational game evaluation frameworks and language learning motivation theories. Content validity was established through expert review by three specialists in Chinese language education and educational technology, who evaluated item clarity, construct alignment, and contextual relevance. Based on their feedback, minor revisions were made to improve wording precision and reduce ambiguity.

A pilot test was subsequently conducted with a small group of learners comparable to the target population. The pilot assessed item comprehensibility, response flow, and preliminary reliability, resulting in minor refinements prior to full deployment.

2) Open-ended feedback

Semi-structured interviews comprising five guiding questions were conducted to explore participants' experiential perceptions, usability concerns, and recommendations for prototype improvement.

Data analysis

Both quantitative and qualitative analyses were performed.

1) Descriptive statistics

Questionnaire reliability was assessed using Cronbach's alpha coefficients. Internal consistency values across the three evaluative dimensions exceeded accepted thresholds for educational research, indicating satisfactory reliability. Mean scores were used to determine evaluative tendencies, while standard deviations indicated response dispersion.

Due to the limited expert sample size ($n = 5$), reliability coefficients were not calculated for expert responses, as small samples may produce unstable estimates. Instead, expert questionnaire data were analyzed descriptively and triangulated with interview findings.

2) Thematic analysis

Qualitative data derived from interviews were analyzed using thematic analysis. This approach enabled the identification of recurring themes related to user experience, motivational engagement, usability concerns, and design improvement needs.

Prototype Description

1) Target users and learning objectives

The prototype targeted learners aged 13–15 with foundational Pinyin knowledge and Chinese proficiency at or below HSK Level 1. It incorporated 36 core vocabulary items organized into three tiers across nine contextual learning scenarios designed to support progressive vocabulary acquisition.

The overall system interface was designed to provide intuitive navigation and clear functional access points. As illustrated in Figure 3, the CM interface homepage presents core menu functions, including gameplay entry, vocabulary database access, language settings, and leaderboard features. Complementing this, Figure 4 displays the vocabulary database module, where learners can review target vocabulary items, including pronunciation, Pinyin, and semantic meanings prior to gameplay engagement.



Figure 3. CM Interface Homepage



Figure 4. Vocabulary Database

2) Core learning mechanism

As illustrated in Figure 5, each learning module begins with a vocabulary preview stage in which learners review vocabulary cards presenting the target word along with its pronunciation and meaning. During gameplay, learners receive both textual and audio prompts and are required to identify corresponding objects within contextualized scenes. This design embeds vocabulary recognition within interactive situational environments, allowing learners to engage with the target vocabulary through observation and interaction. Each vocabulary item is associated with three object instances placed within the scene with varying levels of visibility to encourage attention and cognitive processing.

As shown in Figures 6 – 7, learners follow the word-card prompts and audio instructions to locate and select the matching objects in the scene. When a correct object is selected, it changes from grayscale to color, providing immediate visual feedback. Once all three objects associated with a vocabulary item are correctly identified, the scene becomes fully colored before the system proceeds to the next vocabulary card, indicating successful task completion. Consistent with the findings of Webb (2007), repeated exposure plays a critical role in vocabulary acquisition. Accordingly, each vocabulary item requires learners to complete three matching tasks to reinforce recognition and support memory retention.



Figure 5. Word Card Learning



Figure 6. Matching Items 1



Figure 7. Matching Items 2 and 3

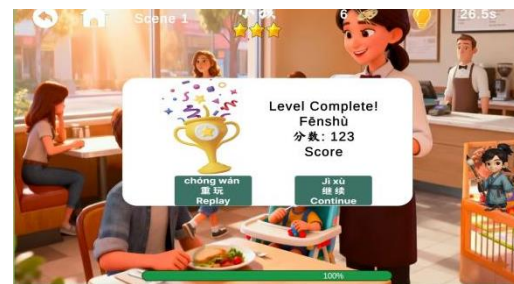


Figure 8. Reward and Feedback

3) Feedback and reward features

To support learner progression, the prototype incorporated scaffolded assistance and motivational reinforcement mechanisms. Learners could access hint functions when encountering difficulties, with usage regulated through task-based rewards.

As illustrated in Figure 8, the system delivered multimodal feedback following task completion. Reward features included star ratings, cumulative point systems, grayscale-to-color visual transitions, and audio responses. In addition, leaderboard rankings were integrated to foster healthy competition and sustained engagement.

Results

Evaluation Results of Existing Digital Games

Table 1 presents key metrics for each game, including activity levels, user base, student-appropriate difficulty levels, and core content. Given that the same game may vary in download numbers and ratings across platforms, the activity levels and user scales are categorized into four tiers (extremely high, high, moderately high, and moderate) based on public data such as app store rankings, user reviews, update frequency, global popularity, and platform coverage. This classification system comprehensively covers the fundamental types and characteristics of current Chinese language learning games.

Table 1.

Basic Information of 10 Games

Game Name	Activity Level	User Volume	Applicable Level	Core Content
Noun Town	Medium–High	Medium	Zero Basic–Elementary	3D interactive scenes, noun learning, situational vocabulary cognition
Lingotopia	Medium	Medium	Zero Basic–Elementary	Exploration and puzzles, picture-word matching, daily basic vocabulary
Learn Chinese HSK	High	High	HSK 1–6	HSK vocabulary flashcards, exercise practice, test-oriented learning
Hero Pro	Medium–High	Medium–High	HSK 1–6	Level challenges, vocabulary and character recognition
Chinese Vocabulary	Medium	Medium	Zero Basic–Intermediate	Thematic vocabulary, pronunciation, spelling practice
Go Play Chinese	Medium–High	Medium	Children & Zero Basic	Cartoon interaction, listening and speaking practice, interesting enlightenment
Hello Chinese	Very High	Very High	Zero Basic—HSK 4	Gamified levels, speech recognition, comprehensive vocabulary learning
Chinese Skill	High	High	Zero Basic–Intermediate	Unit challenges, vocabulary with short sentences, daily communication
Drops	Very High	High	Zero Basic–Elementary	Visual flashcards, short-term high-frequency memorization
Super Chinese	High	Very High	Zero Basic–HSK 5	AI-adaptive learning, situational videos, systematic vocabulary

As shown in Table 2, the 10 games are evaluated across four dimensions: content coverage, design appeal, reward and feedback systems, and accessibility with technical constraints.

Regarding content coverage, most games demonstrate clearly defined instructional objectives. Games such as Learn Chinese HSK, Hero Pro, Hello Chinese, and Super Chinese aligned strongly with HSK

proficiency frameworks, offering vocabulary training across multiple levels. Skill development typically integrates listening, speaking, reading, and writing, with some platforms extending to character writing practice. Conversely, games such as Noun Town, Lingotopia, Go Play Chinese, and Drops targeted travelers or beginner learners, emphasizing practical vocabulary usage and communicative listening–speaking skills.

In terms of design attractiveness, most games employ visually appealing interfaces and color schemes. However, education-oriented platforms such as Learn Chinese HSK and Chinese Vocabulary prioritized knowledge delivery over contextual immersion. In contrast, Noun Town and Lingotopia offered higher levels of interactivity and exploratory engagement.

For reward and feedback systems, most games incorporated motivational incentives, though their structural complexity varied. Some platforms tracked learning progress without structured rewards, while others implemented points, badges, or leaderboard systems. Feedback depth also differed; for example, Lingotopia provided correctness indicators without explanatory scaffolding, whereas Hello Chinese delivered comprehensive corrective feedback.

Regarding accessibility and technical constraints, most games supported both iOS and Android platforms. However, immersive systems such as Noun Town required higher hardware specifications, potentially limiting user access. In addition, many games operate under subscription-based models, creating financial barriers to full functionality.

Table 2.

Analysis of Four Dimensions

Game Name	Content Coverage	Design Attractiveness	Reward & Feedback	Accessibility
Noun Town	1,000 daily nouns	VR 3D immersion	Immediate feedback	VR required
Lingotopia	500 travel words	3D quirky characters	Basic rewards	PC/Mac paid
Learn Chinese HSK	5,000 HSK words	Plain text/audio	Progress tracking	Mobile freemium
Hero Pro	5,000 HSK words	Beautiful UI	Points, static	iOS paid
Chinese Vocabulary	6,000+ words	Simple, monotonous	No reward system	Mobile ads
Go-play Chinese	Task-driven vocab	Cute scenes & stories	Story + stars	Mobile free

Game Name	Content Coverage	Design Attractiveness	Reward & Feedback	Accessibility
Hello Chinese	Full-skills HSK 1-6	Clear gamified UI	Points + medals	Multi-platform
Chinese Skill	HSK 3-4 vocab & grammar	Simple mini-games	Basic correction	Mobile free
Drops	3,000 image-association	Lively timed games	Immediate visual	Time-limited free
Super Chinese	5,000 HSK + AI	Modern dynamic design	Rich rewards	Multi-platform subscription

Overall, existing Chinese vocabulary learning games demonstrate ongoing pedagogical refinement. While immersive contextual learning and structured reward systems offer valuable design references, challenges remain in balancing gameplay engagement, accessibility, and economic feasibility. These findings informed the design direction of the developed prototype.

Based on the comparative analysis of the ten selected digital games, several recurring strengths and limitations were identified and subsequently used to inform the design of the Color Master (CM) prototype. Many existing applications demonstrate strong capabilities in creating immersive learning environments, interactive gameplay, and reward-based motivational mechanisms. Features such as scenario-based interaction, visual object recognition, and structured reward systems were therefore incorporated into the prototype design in order to enhance learner engagement and support contextualized vocabulary learning.

At the same time, the analysis also revealed several common limitations across existing games. These include high technical requirements, excessive reliance on English interfaces, limited feedback mechanisms, overly complex interfaces, and restricted accessibility due to hardware requirements or subscription-based access. To address these issues, the CM prototype was designed with simplified interaction mechanisms, clear interface structures, and beginner-friendly learning tasks aligned with HSK Level 1 vocabulary. In addition, multimodal feedback and gamification elements—such as visual rewards, points, and leaderboard systems—were incorporated to enhance learner motivation and provide immediate feedback during gameplay.

Furthermore, several design features were adapted from the strengths observed in existing applications. For example, immersive scene-based exploration inspired by games such as Noun Town and Lingotopia informed the development of contextualized learning environments, while image-based vocabulary recognition and repetition mechanisms were integrated to reinforce vocabulary retention. At the same time, the prototype reduces technical barriers by prioritizing cross-device compatibility and simplified

gameplay structures to ensure accessibility for beginner learners.

Overall, the prototype design synthesizes the effective design elements identified in existing Chinese language learning games while addressing their commonly observed limitations. By combining contextualized vocabulary learning, gamified motivational features, and accessible interface design, the CM prototype aims to provide a balanced learning environment that supports both learner engagement and instructional effectiveness.

Evaluation Results of the Digital Game Prototype

1) Content Appropriateness

As shown in Tables 3 and 4, the student questionnaire demonstrated excellent internal consistency (Cronbach's alpha = 0.946), with an overall mean score of 4.07 (SD = 0.708), indicating generally positive learner perceptions of the vocabulary content design. Expert evaluations were similarly favorable, with mean scores ranging from 4.00 to 5.00 across indicators. Items related to lexical accuracy, pronunciation clarity, and alignment with learning objectives received particularly high ratings (4.80–5.00), while low standard deviation values indicated strong agreement among experts.

Table 3.

Questionnaire Results of Students on the Dimension of Content Appropriateness

Scale	Mean	SD	Cronbach's alpha
Overall Scale	4.07	0.708	0.946

Interview findings further supported these results. Learners reported that the multimodal presentation of vocabulary—including pinyin, audio pronunciation, translation, and visual representation—facilitated comprehension. Some participants, however, suggested incorporating more advanced vocabulary to provide a clearer progression in difficulty.

Overall, the results indicate that the prototype demonstrates strong content appropriateness and alignment with learners' needs, although further refinement in vocabulary difficulty progression may enhance instructional effectiveness.

Table 4.

Questionnaire Results of Experts on the Dimension of Content Appropriateness

Item	N	Mean	SD
EC1	5	4.80	0.447
EC2	5	4.80	0.447
EC3	5	4.80	0.447
EC4	5	4.40	0.894

Item	N	Mean	SD
EC5	5	4.60	0.548
EC6	5	4.80	0.447
EC7	5	4.60	0.548
EC8	5	4.60	0.548
EC9	5	4.20	0.837
EC10	5	5.00	0.000
EC11	5	4.60	0.548
EC12	5	4.60	0.548
EC13	5	4.00	1.000
EC14	5	4.60	0.548
EC15	5	5.00	0.000

2) Learning Motivation

Following the recording of negatively worded items as shown in Tables 5 and 6, reliability analysis indicated high internal consistency for the learning motivation scale (Cronbach's alpha = 0.922). The overall mean score was 3.94 (SD = 0.673), suggesting that the prototype effectively stimulated learner motivation. Expert evaluations also showed highly positive perceptions, with mean scores ranging from 4.40 to 5.00 across all indicators.

Table 5.

Questionnaire Results of Students on the Dimension of Learning Motivation

Scale	Mean	Standard Deviation	Cronbach's alpha
Overall Scale	3.94	0.673	0.922

Interview responses further highlighted the motivational value of the gamified features. Participants reported that level progression, point accumulation, and reward mechanisms enhanced enjoyment and encouraged continued engagement with the learning tasks. Nevertheless, some learners noted that certain levels were relatively time-consuming, which occasionally reduced motivation.

In summary, the findings indicate that the gamification elements embedded in the prototype effectively support learning motivation, although minor adjustments to task difficulty and duration could further improve the learning experience.

Table 6.

Questionnaire Results of Experts on the Dimension of Learning Motivation

Item	N	Mean	Standard Deviation
EM1	5	5.00	0.00

Item	N	Mean	Standard Deviation
EM2	5	5.00	0.00
EM3	5	4.80	0.447
EM4	5	4.80	0.447
EM5	5	4.60	0.548
EM6	5	4.80	0.447
EM7	5	4.40	0.548
EM8	5	4.40	0.894
EM9	5	4.60	0.548
EM10	5	4.80	0.447
EM11	5	4.80	0.447
EM12	5	4.80	0.447
EM13	5	4.60	0.548
EM14	5	4.40	0.548
EM15	5	4.80	0.447

3) Usability

As shown in Tables 7 and 8, the usability dimension also demonstrated high reliability, with a Cronbach's alpha coefficient of 0.937. The overall mean score of 3.83 (SD = 0.756) suggests that learners generally perceived the system as usable and supportive of vocabulary learning activities. Expert evaluations likewise reflected positive perceptions, with mean scores ranging from 3.40 to 5.00 across usability indicators. Experts particularly highlighted the clarity of the interface design, navigation structure, and operational functionality.

Table 7.

Questionnaire Results of Students on the Dimension of Usability

Scale	Mean	Standard Deviation	Cronbach's alpha
Overall Scale	3.83	0.756	0.937

Interview findings provided additional insights into user experience. Participants generally agreed that the interface was visually clear and that navigation was intuitive. The integration of multimodal feedback and visual reward mechanisms further enhanced engagement. However, several usability issues were noted, including slower loading under unstable network conditions and reduced visual clarity on smaller mobile screens.

Overall, the results indicate that the prototype achieved satisfactory usability and provided a generally smooth user experience, although improvements in network performance and device compatibility would further strengthen system usability.

Table 8.

Questionnaire Results of Experts on the Dimension of Usability

Item	N	Mean	Standard Deviation
EU1	5	4.40	0.548
EU2	5	4.60	0.548
EU3	5	4.20	0.837
EU4	5	4.60	0.548
EU5	5	4.40	0.548
EU6	5	4.60	0.548
EU7	5	5.00	0.00
EU8	5	5.00	0.00
EU9	5	4.80	0.447
EU10	5	5.00	0.00
EU11	5	4.60	0.894
EU12	5	3.40	0.548
EU13	5	5.00	0.00
EU14	5	4.40	0.548
EU15	5	3.60	0.548

For overall summary, across the three evaluation dimensions, both quantitative results and qualitative feedback consistently indicate positive perceptions of the prototype. The system demonstrates strong alignment between instructional content, motivational game design, and usability features. At the same time, several areas for refinement were identified, including vocabulary difficulty progression, task duration, interface adaptation for smaller screens, and loading stability. These findings provide clear directions for further prototype development and system optimization.

■ Discussion

This study analyzed ten existing Chinese language learning games to identify recurring pedagogical strengths and design limitations and used these insights to inform the development of the Color Master (CM) prototype. Comparative analysis indicates that many platforms effectively employ situational immersion, interactive learning environments, and reward-based mechanisms to enhance learner engagement. However, several limitations remain, including restricted accessibility, an imbalance between gameplay and instructional content, platform dependency, and relatively high technical requirements. These observations are consistent with previous studies suggesting that educational games often encounter challenges such as misalignment between learning objectives and game design, technological barriers, and limited accessibility (Nihayatul, 2022; Wang, 2019).

To address these limitations, the CM prototype integrates target vocabulary into interactive situational tasks designed to support contextualized and experiential learning. This design approach aligns with prior research indicating that immersive digital environments can facilitate vocabulary recognition, comprehension, and retention (Wu, 2025). To ensure pedagogical relevance and content validity, all vocabulary items were aligned with HSK Level 1 standards. In addition, the system incorporates gamified features such as multimodal feedback, point accumulation, and leaderboard mechanisms, which are consistent with findings that gamification can enhance learner motivation and reduce learning anxiety (Hamari, 2014; Vnucko, 2023). Furthermore, the prototype prioritizes cross-device compatibility to improve accessibility and reduce platform-related constraints, thereby supporting sustained engagement in vocabulary learning (Zheng, 2015).

The evaluation results further indicated generally favorable perceptions from both learners and expert reviewers regarding content appropriateness, learning motivation, and usability, thereby supporting the pedagogical relevance and functional feasibility of CM at the prototype stage. Although reliability coefficients and mean ratings were high, the evidence should be interpreted primarily as perception-based evaluative support rather than as conclusive evidence of learning effectiveness. Nonetheless, the overall pattern is congruent with prior scholarship suggesting that game-based learning environments are more likely to yield meaningful educational outcomes when instructional content is coherently aligned with curricular objectives, contextual authenticity is maintained, and cognitive demands are appropriately managed (Plass, 2015; Peterson, 2016). In addition, CM's incorporation of structured feedback and reward elements is theoretically consistent with gamification research indicating that well-designed incentive systems can enhance learners' motivation and persistence over time (Hamari, 2014).

Notwithstanding these strengths, the findings also identified areas requiring further refinement. First, the current content progression strategy is primarily determined by vocabulary quantity rather than by linguistic complexity or difficulty, indicating the need for a more systematic sequencing framework that better reflects developmental learning trajectories and supports incremental mastery. Second, technical and device-related conditions shaped usability perceptions: intermittent network instability occasionally reduced system responsiveness, and smaller mobile displays constrained visual clarity during certain gameplay interactions. Accordingly, future iterations should prioritize (i) a principled progression design that integrates difficulty gradients and scaffolding, (ii) interface scalability and readability optimization across screen sizes, and (iii) performance improvements under variable bandwidth conditions. Collectively, these refinements would strengthen the robustness of the learner experience and provide a more substantial basis for broader implementation and subsequent effectiveness-oriented evaluation.

■ Conclusion

This study systematically analyzed existing Chinese language learning games to inform the design and development of the Color Master (CM) prototype. Based on the pedagogical strengths and design limitations identified across current platforms, the

prototype integrates contextualized vocabulary learning, curriculum-aligned content, and gamified motivational features. Evaluation results from both experts and learners indicate generally positive perceptions across the three evaluation dimensions: content appropriateness, learning motivation, and usability. These findings provide empirical insights into the design and evaluation of digital game-based vocabulary learning environments and highlight the value of incorporating both expert pedagogical perspectives and learner experience in the development of digital language learning tools.

■ Limitations

Despite these contributions, several limitations should be acknowledged. First, network and time constraints prevented a small number of student participants from completing all gameplay levels, which may have influenced some questionnaire responses. Second, the relatively small expert panel, although appropriate for prototype-stage evaluation, limits the generalizability of the findings. In addition, while the questionnaire demonstrated high internal consistency (Cronbach's alpha = 0.946, 0.922, and 0.937), these estimates were derived from a relatively small learner sample ($N = 23$) and should therefore be interpreted as preliminary reliability evidence. Future research should further refine the prototype based on the feedback obtained in this study and conduct evaluations with larger and more diverse learner populations. Subsequent studies may examine the implementation of the system in classroom settings and other instructional contexts to provide stronger evidence regarding its effectiveness and scalability.

■ References

- Liu, X. (2000). *An introduction to teaching Chinese as a foreign language*. Beijing: Beijing Language and Culture University Press.
- Zhang, H. (2006). A quantitative study on Chinese vocabulary learning of foreign students. *Chinese Teaching in the World*, (1).
- Zou, D., & Rufe, Z. (2023). Learner engagement in digital game-based vocabulary learning and its effects on EFL vocabulary development. *System*.
- Zhao, L. (2020). *An action research on gamified Chinese teaching using Kahoot! and Quizlet* (Master's thesis). East China Normal University.
- Rosalin, K., & Ying, Y. (2024). Chineseway apps as Chinese vocabulary learning tools.
- Yuan, H., & Wang, Z. (2021). A review of research on technology enhancing Chinese learning.
- Yudintseva, A. (2015). Game-enhanced second language vocabulary acquisition strategies: A systematic review.
- Prensky, M. (2003). Digital game-based learning. *ACM Computers in Entertainment*, October.
- Wu, J. G., & Zhang, D. (2025). Game on! Digital gaming and augmented reality/virtual reality in language learning.

- Sykes, J. M. (2018). Digital games and language teaching and learning. *Foreign Language Annals*. <https://doi.org/10.1111/flan.12325>
- Chiu, Y. H., Kao, C. W., & Reynolds, B. L. (2012). The relative effectiveness of digital game-based learning types in English as a foreign language setting: A meta-analysis.
- Piaget, J. (1970). *Science of education and the psychology of the child*. New York: Viking Press.
- Zheng, D. (2015). Vocabulary learning in massively multiplayer online games: Context and action before words.
- Ovilia, R., & Warat, R. D. (2017). Digital games in digital learning environment: What makes them effective in embodying vocabulary mastery.
- Vnucko, G., & Klimova, B. (2023). Exploring the potential of digital game-based vocabulary learning: A systematic review.
- Skinner, B. F. (1953). *Science and human behavior*. New York: Macmillan.
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.
- Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist*, 50(4), 258–283.
- 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.
- Peterson, M. (2016). The use of digital games in L2 teaching and learning. *Language Learning & Technology*, 20(3), 1–6.
- Gan, Z. H. (2021). *Research on design and development of primary school English vocabulary digital educational game (Master's thesis)*. Northwest Normal University.
- Gao, X. (2019). *Instructional design and research of comprehensive TCFL course based on Kahoot! platform (Master's thesis)*. Beijing Foreign Studies University.
- Fan, Y., & Cui, J. (n.d.). *Development and application research of an online educational game evaluation rubric*.
- Xue, X., & Zhao, Y. (2019). Construction of evaluation index system for gamification design of public science projects based on analytic hierarchy process. *Library and Information*, (3).
- Liu, W., & Wang, Y. (2017). Design and development of evaluation indicators for educational games. *Open Education Research*.
- Zhou, Y., & Jiang, S. (2015). Research on evaluation model and index weight of online games. *China Educational Technology*.
- Abramovich, S., Schunn, C., & Higashi, R. M. (2013). Are badges useful in education? It depends upon the type of badge and expertise of learner. *Educational Technology Research and Development*, 61(2), 217 – 232. <https://doi.org/10.1007/s11423-013-9289-2>
- Yusri, A. A. (2025). Unleashing gamification: A systematic review in primary schools. *Journal of Education and Learning*, 14(6), 2315 – 2332. <https://doi.org/10.11591/edulearn.v14i6.28976>

- Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, 105(2), 249 – 265. <https://doi.org/10.1037/a0031311>
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row.
- Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33(4), 441 – 467.
- Hung, P. X., et al. (2018). Digital game-based language learning: A systematic review. *Journal of Computer Assisted Learning*, 34(5), 577 – 595.
- Xu, X. Y., & Huang, G. Y. (2014). Evaluation and analysis of educational games for teaching Chinese as a foreign language: A case study of New Wind Chinese (Zon). *Journal of Guangdong University of Education*, 34(4), 7 – 13.