Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2, 366-378
2026
Publisher: Learning Gate
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

The impact of immediate feedback and leaderboards on cognitive load and vocabulary learning strategies: An SEM approach in online Chinese learning

Yan Song[1], Sirirat Petsangsri[2*], Thanin Rattana-Olan[3], Jianming Cui[4]
[1]School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand; liujiapiao74robin@126.com (Y.S.).
[2,3]School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand; sirirat.pe@kmitl.ac.th (S.P.) thanin.ra@kmitl.ac.th (T.P.).
[4]School of Humanities and International Studies, Zhejiang University of Water Resources and Electric Power, Zhejiang, China; cui_jm@zjweu.edu.cn (J.C.).

Abstract: The rapid expansion of online education has intensified long-standing challenges related to sustaining learner engagement and managing cognitive resources in virtual classrooms. These challenges are particularly salient in online Chinese vocabulary courses, where learners must acquire and retain a large volume of unfamiliar lexical items. This study disentangles the effects of two specific gamification features, immediate feedback and leaderboards, on cognitive load, vocabulary learning strategies, and vocabulary achievement. Sixty undergraduate students enrolled in an online HSK preparation course were randomly assigned to one of three conditions: immediate feedback, leaderboards, or a non-gamified control group. Over six weeks, participants completed weekly Quizizz-based vocabulary quizzes, a NASA-TLX measure of perceived cognitive load, and a Vocabulary Learning Strategies Questionnaire. Path analysis within a structural equation modeling (SEM) framework revealed that immediate feedback significantly reduced cognitive load and promoted more frequent use of vocabulary learning strategies, which in turn were associated with higher post-test scores. In contrast, leaderboards increased cognitive load while still enhancing strategic vocabulary learning behaviors. The findings extend cognitive load theory and gamification research by clarifying the distinct pathways through which specific game elements influence mental effort and strategic behavior.

Keywords: *Gamification, Immediate feedback, Leaderboards, Cognitive load, Vocabulary learning strategies.*

1. Introduction

The rapid expansion of online education, accelerated by recent global shifts toward virtual learning, has intensified long-standing challenges related to learner engagement, motivation, and cognitive resource management. These challenges are particularly pronounced in online language courses, where learners must process complex input, manage high volumes of information, and sustain attention over extended periods. In the context of Chinese as a second language, vocabulary learning presents a specific difficulty, as learners must memorize a large set of novel characters, forms, and meanings while simultaneously developing comprehension and productive skills. Designing online environments that both motivate learners and manage their cognitive load is therefore a central concern for language educators.

Gamification has emerged as a promising approach for addressing these challenges. Rather than treating gamification as a monolithic construct, recent work has emphasized the need to examine the effects of specific game design elements, such as immediate feedback, leaderboards, points, and badges, on learning processes and outcomes. When thoughtfully aligned with pedagogical goals, gamification can foster engagement, persistence, and formative use of feedback; however, poorly calibrated game

© 2026 by the authors; licensee Learning Gate
History: Received: 19 November 2025; Revised: 9 January 2026; Accepted: 14 January 2026; Published: 9 February 2026
* Correspondence: sirirat.pe@kmitl.ac.th

elements can also induce unnecessary stress and cognitive overload. In language education, gamified assessments have been shown to support participation and provide rich feedback in digital environments, but the mechanisms through which individual elements operate remain underspecified.

Among the most widely implemented gamification features are immediate feedback and leaderboards. Immediate feedback provides learners with real-time information about the correctness of their responses and, in some cases, brief explanations, potentially reducing extraneous cognitive load and supporting self-regulation during learning. Leaderboards, in contrast, leverage social comparison and competition by displaying learners' relative performance, which may boost engagement and encourage strategic behavior, yet may also increase anxiety and perceived effort. Existing studies often bundle these elements under a global "gamification" label, making it difficult to determine their distinct cognitive and motivational effects, especially in online Chinese vocabulary learning.

This study addresses this gap by empirically examining the separate effects of immediate feedback and leaderboards on cognitive load and vocabulary learning strategies in an online Chinese learning context. Its originality lies in isolating these two gamified assessment features within the same instructional environment and modeling how they relate to mental effort, strategic vocabulary learning, and vocabulary achievement. Using a randomized experimental design and a path model estimated within a structural equation modeling (SEM) framework, the study moves beyond simple group comparisons to examine plausible indirect pathways linking gamification elements to learning outcomes. Specifically, the study pursues three objectives:

1. To investigate how immediate feedback affects cognitive load and vocabulary learning strategies in online Chinese learning.
2. To examine the differential impact of leaderboards on cognitive load and vocabulary learning strategies.
3. To explore how cognitive load and vocabulary learning strategies relate to vocabulary achievement and may function as intervening processes linking gamified assessment features to learning outcomes.

By addressing these objectives, the study extends the theoretical understanding of cognitive load and motivation in gamified online learning and offers educators actionable insights for strategically integrating specific gamification elements into online Chinese language instruction.

2. Literature Review

2.1. Gamification in Online Language Education

Gamification refers to the use of game design elements in non-game contexts with the aim of enhancing user engagement and motivation [1]. In educational settings, gamification can incorporate elements such as points, badges, leaderboards, progress bars, and feedback dashboards to encourage sustained participation and scaffold learning processes. When these elements are aligned with pedagogical goals and assessment practices, empirical studies and reviews generally report positive effects on motivation, engagement, and learning outcomes [2-5].

In language education, gamified assessment has been widely used to support repeated practice, formative feedback, and learner autonomy in digital environments. Tools such as Quizizz, Kahoot!, and other quiz-based platforms allow instructors to integrate game elements into vocabulary and grammar exercises, often resulting in increased participation and enjoyment [6, 7]. Gamification is particularly relevant for vocabulary learning, where repeated exposure and active retrieval are crucial for long-term retention. Yet, much of the existing research treats gamification as a single, aggregated intervention, making it difficult to disentangle the effects of specific game elements on learners' cognitive and strategic processes, especially in online Chinese vocabulary learning.

2.2. Immediate Feedback

Immediate feedback is a central feature of many gamified systems. From the perspective of cognitive

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

load theory, learners' working memory resources are limited, and instructional designs should therefore aim to reduce extraneous load and optimize germane load for effective learning [8, 9]. Immediate corrective feedback provides learners with real-time information about the accuracy of their responses and, in some cases, brief explanations of errors, allowing them to adjust their schemas before misconceptions become entrenched. By clarifying task requirements and reducing uncertainty, such feedback can lower extraneous cognitive load and support more efficient processing during practice activities [10].

Beyond cognitive load theory, feedback research has consistently shown that timely, specific feedback can substantially improve learning outcomes when it helps learners close the gap between current and desired performance [11]. Immediate feedback, in particular, can foster metacognitive engagement by prompting learners to monitor their understanding, evaluate their strategies, and plan subsequent actions. In technology-enhanced environments, such feedback has been associated with improved knowledge retention, higher self-efficacy, and more active self-regulation [12-14].

In gamified quizzes, immediate feedback is typically delivered through visual cues (e.g., color-coded correctness bars), textual explanations, and real-time performance indicators. Figure 1 illustrates the Quizizz immediate feedback dashboard used in this study, where item-level correctness bars (green = correct; red = incorrect) are updated in real time alongside summary metrics such as class progress, items completed, and the number of participants. This visualization supports rapid error detection and pacing during gamified assessment, enabling learners to allocate their cognitive resources more efficiently while engaging in repeated vocabulary practice.

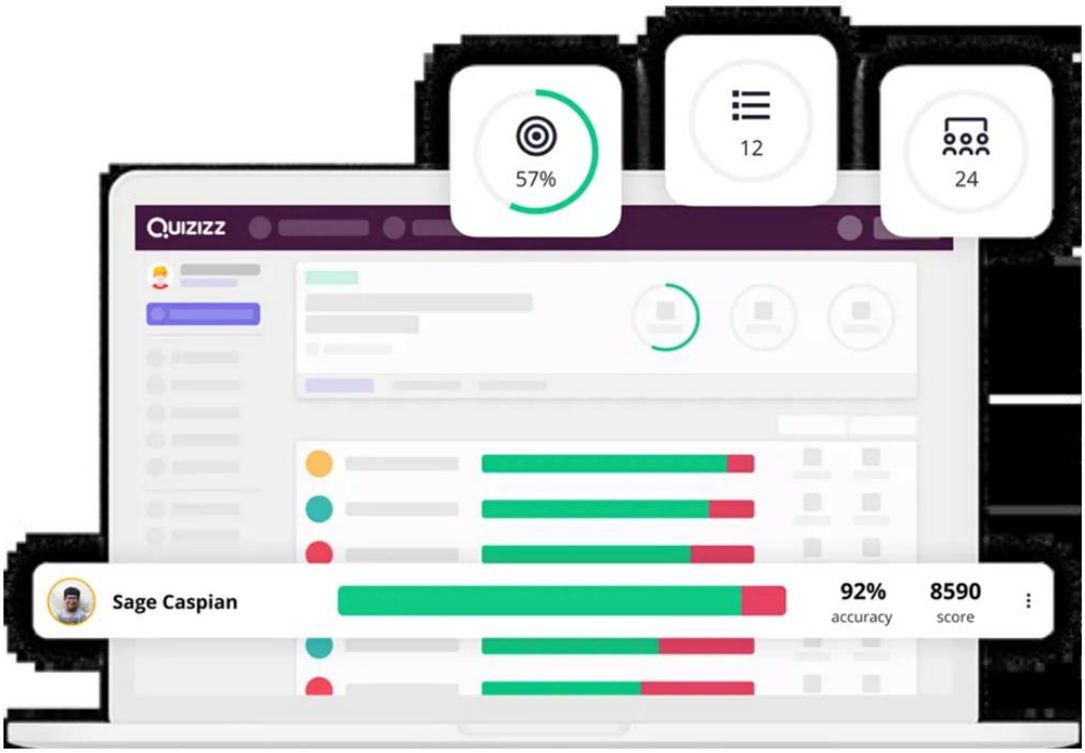

Figure 1.
Quizizz's immediate feedback dashboard with real-time performance indicators.

Screenshot illustrating immediate feedback: item-level correctness bars (green = correct; red = incorrect) update in real time alongside summary metrics (class progress gauge, items completed, participants). This visualization supports rapid error detection and pacing during gamified assessment.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

2.3. Leaderboards and Cognitive Load

Leaderboards are another prevalent gamification feature, typically designed to rank learners according to performance indicators such as points, accuracy, or speed. Their motivational potential is grounded in social comparison theory, which posits that individuals evaluate their abilities by comparing themselves with others [15]. By making relative performance salient, leaderboards can stimulate competition, goal setting, and persistence, often leading learners to invest more effort and experiment with new strategies to improve their standing [16, 17]. In language courses, leaderboards have been shown to increase participation and engagement in online tasks when implemented with clear goals and transparent scoring rules [6, 18].

However, leaderboards can also introduce emotional pressure and perceived performance expectations that elevate cognitive load. When learners focus excessively on rank, they may experience anxiety, frustration, or fear of failure, which can divert cognitive resources away from the learning task. From the perspective of self-determination theory, competition can either support or undermine intrinsic motivation depending on whether it is experienced as autonomy-supportive (e.g., voluntary challenges) or controlling [19]. Learners with strong competitive orientations may thrive in leaderboard environments, whereas those with high anxiety or low self-efficacy may disengage or experience overload [18, 20]. These mixed findings highlight the dual-edged nature of leaderboards and the importance of contextual factors, such as anonymity, task difficulty, and classroom climate.

In the present study, leaderboards were operationalized as a class-level ranking of quiz scores. Figure 2 displays the Quizizz leaderboard interface, which shows learners' current rank, cumulative points, and answer-level correctness bars. This real-time comparative feedback supports goal setting and pacing, but can also trigger competitive pressure as learners monitor their position. To protect participants' privacy, pseudonyms can be used in research contexts when reporting leaderboard data.

Figure 2.
Quizizz leaderboard with real-time ranks, points, and accuracy.

2.4. Cognitive Load and Vocabulary Learning Strategies

Cognitive load theory distinguishes among intrinsic, extraneous, and germane cognitive load, emphasizing that instructional materials should manage intrinsic load, minimize extraneous load, and foster germane load that directly contributes to schema construction [8]. In computer-mediated

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

environments, gamification elements such as timers, visual effects, and competitive features can either reduce extraneous load by structuring tasks and providing clear feedback or increase it by introducing distractions and time pressure [10]. Recent studies report that gamification can sometimes increase overall cognitive load while still enhancing engagement, suggesting a complex interplay between mental effort and motivational benefits. Despite these theoretical insights, few studies empirically examine the distinct effects of immediate feedback and leaderboards on cognitive load and vocabulary learning strategies in online Chinese language learning environments. Addressing this gap, this study employs a rigorous SEM approach, providing comprehensive insights and empirical evidence to support nuanced gamification implementations in online language education.

In vocabulary learning, cognitive load is particularly salient because learners must encode form–meaning mappings, manage interference among similar items, and apply new vocabulary in context. Well-designed gamified assessments can help manage this complexity by breaking content into smaller units, providing repeated retrieval opportunities, and supplying immediate feedback to prevent the accumulation of misconceptions. At the same time, competitive game features may add a layer of mental effort as learners monitor their performance relative to others. Understanding how specific gamification elements influence perceived cognitive load is, therefore, crucial for designing vocabulary learning environments that are both engaging and cognitively manageable.

2.5. Vocabulary Learning Strategies

Effective vocabulary learning relies heavily on learners' ability to deploy appropriate learning strategies. Vocabulary learning strategies are typically conceptualized as a subset of general language learning strategies and include memory, cognitive, metacognitive, and social/affective strategies [21, 22]. Memory strategies involve techniques such as mnemonic devices, imagery, and keyword methods; cognitive strategies encompass repetition, note-taking, and dictionary use; metacognitive strategies refer to planning, monitoring, and evaluating one's learning; and social strategies involve interacting with peers or teachers to negotiate meaning and receive feedback. Empirical research has shown that successful learners tend to use a broad repertoire of vocabulary learning strategies flexibly and in combination [23, 24].

In digital and gamified learning environments, vocabulary learning strategies may be shaped by the affordances of the platform and the nature of the game elements. Immediate feedback can directly support metacognitive strategies by signaling errors, prompting reflection, and encouraging learners to adjust their study plans. For example, seeing item-level feedback after each response can help learners identify which words require additional practice and which strategies (e.g., elaboration vs. rote memorization) are effective. Leaderboards, in contrast, may indirectly influence strategy use by motivating learners to invest more time, attempt more challenging items, or adopt more efficient learning techniques to improve their rank. Recent studies on gamified mobile and online language learning suggest that gamification can foster self-regulation and strategic learning when learners perceive game elements as informative and autonomy-supportive rather than controlling [14, 25].

Despite these theoretical insights, relatively few studies have empirically examined the distinct effects of immediate feedback and leaderboards on both cognitive load and vocabulary learning strategies within a single research design, particularly in online Chinese language learning environments. Existing research tends either to aggregate game elements into a single "gamified condition" or to focus on motivational variables without simultaneously modeling cognitive and strategic processes. The present study, therefore, contrasts immediate feedback and leaderboards within a unified SEM framework to clarify their separate pathways to vocabulary achievement, with a specific focus on how these gamification elements shape learners' perceived cognitive load and reported vocabulary learning strategies in an online HSK vocabulary course.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

3. Materials and Methods

3.1. Participants

Sixty undergraduate students enrolled in an online HSK preparation course for Chinese at Sichuan University participated in this study.

Sampling frame and selection: A stratified random sampling approach was used to draw the study sample from the enrollment roster. Strata were defined by gender (female/male) to ensure proportional representation of each subgroup in the sample. Within each stratum, students were selected at random until the target size of N=60 was reached. This sampling step was completed before any experimental assignment.

Assignment to conditions: After sampling, participants were randomly assigned in equal groups (n=20 per condition) to Immediate Feedback, Leaderboards, or Control, using block randomization within strata (gender). This procedure preserved gender balance across conditions and avoided confounding sampling with treatment assignment.

Participant characteristics: Participants were undergraduates enrolled in a standardized online HSK preparation course. Baseline characteristics (gender distribution, initial HSK vocabulary proficiency) were recorded and checked for equivalence across conditions before analysis.

Table 1.
Participant characteristics and baseline equivalence

Characteristic	Immediate Feedback (n = 20)	Leaderboards (n = 20)	Control (n = 20)	Total
Gender, female, n (%)	12 (60%)	12 (60%)	12 (60%)	36 (60%)
Gender, male, n (%)	8 (40%)	8 (40%)	8 (40%)	24 (40%)
Age (years), M (SD)	19.9 (0.9)	20.1 (1.0)	20.0 (1.1)	20.0 (1.0)
Pre-test vocabulary score[1], M (SD)	33.6 (5.7)	33.4 (5.9)	33.3 (6.0)	33.4 (5.8)

3.2. Instruments

3.2.1. NASA Task Load Index (NASA-TLX)

This instrument measured cognitive load across six dimensions: mental demand, physical demand, temporal demand, effort, performance, and frustration. NASA-TLX demonstrates strong psychometric properties, with reported reliability coefficients (Cronbach's alpha) consistently above .80 in previous research [26].

3.2.2. Vocabulary Learning Strategies Questionnaire (VLSQ)

Adapted from Oxford [21] comprehensive strategy inventory, the VLSQ assesses memory, cognitive, metacognitive, and social strategies specifically for vocabulary learning. The instrument was pilot-tested among a similar population (n=30), confirming high internal consistency (Cronbach's α = .89) and construct validity through exploratory factor analysis.

3.2.3. Vocabulary Achievement Test

Vocabulary retention was evaluated through standardized tests derived from the HSK Level 3 official vocabulary list. Tests were administered pre- and post-intervention, containing 50 multiple-choice and matching items. Reliability was confirmed through pilot testing (Cronbach's α = .87).

Operationalization of vocabulary achievement involved using the post-intervention score on the HSK-based vocabulary test for structural analysis. Pre-test scores assessed baseline equivalence among the three groups (see Table 1). However, only the post-test score was included as the outcome variable in the structural model.

3.3. Procedure

The intervention spanned six weeks and consisted of weekly online vocabulary quizzes administered via the Quizizz platform.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

Design details and scoring: Weekly quizzes were scored by accuracy only (correct = 1, incorrect = 0) and rescaled to 0–100. Identical scoring rules were applied across all conditions. No time or streak bonuses were used in the computation of scores.

Leaderboard condition: Scores were ranked on a class leaderboard to provide comparative feedback; the leaderboard itself did not augment scores (i.e., no multipliers, badges, or bonuses were derived from it).

Immediate Feedback condition: Item-level correctness and brief explanations were shown immediately after each response. Students were not permitted to retry items within a quiz session; feedback served only a formative purpose.

Control condition: Students completed the same weekly quizzes without leaderboards and without immediate item-level explanations; only overall scores were shown at the end of each quiz. Implementation controls: All conditions used the same quiz forms, item ordering, time limits, and device access rules. The instructor, meeting schedule, and instructional materials were held constant across conditions.

Data collection followed ethical approval guidelines, ensuring participant anonymity and voluntary participation, and included pre- and post-tests, cognitive load surveys (NASA-TLX), VLSQ surveys, and qualitative semi-structured interviews post-intervention.

4. Result and Discussion

4.1. Data Analysis

4.1.1. Descriptive Statistics and Reliability

Before estimating the structural model, descriptive statistics, internal consistency, and bivariate correlations among the main study variables were examined. Table 2 reports the means, standard deviations, Cronbach's alpha coefficients, and Pearson correlations for cognitive load, vocabulary learning strategies, and vocabulary achievement.

Table 2.
Descriptive statistics, reliability, and correlations.

Variable	M	SD	α	1	2	3
1. Cognitive Load	55.2	12.3	0.88	—		
2. Vocabulary Learning Strategies	3.54	0.62	0.9	-0.3	—	
3. Vocabulary Achievement (Post)	41.3	4.9	0.86	-0.57	0.72	—

Note: α = Cronbach's alpha. Pearson correlations are reported below the diagonal. All reliability coefficients and correlations are based on the full sample (N = 60).

4.1.2. Structural Equation Modeling (SEM)

Structural equation modeling was conducted in AMOS 26.0 to examine the relationships among immediate feedback, leaderboards, cognitive load, vocabulary learning strategies, and vocabulary achievement in online Chinese vocabulary learning. The hypothesized model showed a good fit to the data ($\chi^2/df = 1.87$, CFI = .95, RMSEA = .05), satisfying commonly recommended cut-off values. These indices support the adequacy of the proposed SEM structure summarized in Figure 3. Because the study's primary focus was on the structural relations among composite scores rather than on latent measurement models, all constructs were represented by observed composite scores (scale means). The structural model specified paths from the gamification conditions to cognitive load and vocabulary learning strategies, and from these two variables to vocabulary achievement; direct paths from immediate feedback and leaderboards to vocabulary achievement were not included. The model can therefore be regarded as a path analysis estimated within the SEM framework that explores plausible indirect pathways through cognitive load and vocabulary learning strategies rather than providing a formal test of statistical mediation.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

4.2. Results

4.2.1. Direct Effects of Gamified Features on Cognitive Load and Strategy Use

As shown in Figure 3, immediate feedback exerted a significant negative impact on learners' perceived cognitive load ($\beta = -0.42$, SE = 0.08, $t = -5.25$, $p < .001$), indicating that providing item-level corrections and explanations helped students manage task demands more efficiently during online vocabulary quizzes. In contrast, leaderboards were positively associated with cognitive load ($\beta = 0.37$, SE = 0.09, $t = 4.11$, $p < .001$), suggesting that the competitive environment increased mental effort and pressure while students monitored their relative performance.

Both gamified features positively influenced vocabulary learning strategies. Immediate feedback had a slightly more substantial positive effect on strategy use ($\beta = 0.55$, SE = 0.07, $t = 7.86$, $p < .001$) than leaderboards ($\beta = 0.48$, SE = 0.08, $t = 6.00$, $p < .001$). These findings indicate that both design elements encouraged learners to adopt more systematic vocabulary learning strategies, with immediate feedback providing more direct support for planning, monitoring, and revising their study approaches.

4.2.2. Effects of Cognitive Load And Strategies on Vocabulary Achievement

Downstream effects on vocabulary achievement further highlight the model's central role of mental and strategic processes. Cognitive load negatively predicted vocabulary achievement ($\beta = -0.39$, SE = 0.08, $t = -4.88$, $p < .001$), showing higher perceived mental demands and effort associated with lower post-test scores. Conversely, vocabulary learning strategies exerted a strong positive effect ($\beta = 0.60$, SE = 0.07, $t = 8.57$, $p < .001$), indicating that learners who reported more frequent use of memory, cognitive, and metacognitive strategies achieved better performance on the HSK-based vocabulary tests.

4.2.3. Summary of the SEM Pathways

Taken together, the SEM results suggest that immediate feedback is associated with lower perceived cognitive load and more frequent use of vocabulary-learning strategies, whereas leaderboards are associated with higher cognitive load alongside increased strategy use. Within the present path model, vocabulary achievement is negatively related to cognitive load and positively related to vocabulary learning strategies, indicating that learners in the immediate feedback condition tended to report more favorable cognitive and strategic profiles that, in turn, corresponded to higher post-test scores. These findings should be interpreted as evidence of plausible indirect pathways rather than as definitive proof of statistical mediation.

SEM path coefficients demonstrated the following significant relationships (see Table 3):

- Immediate feedback reduced cognitive load ($\beta = -0.42$, SE = 0.08, $t = -5.25$, $p < .001$).
- Leaderboards increased cognitive load ($\beta = 0.37$, SE = 0.09, $t = 4.11$, $p < .001$).
- Both features positively influenced vocabulary learning strategies, with a more substantial effect for immediate feedback ($\beta = 0.55$, SE = 0.07, $t = 7.86$, $p < .001$) than for leaderboards ($\beta = 0.48$, SE = 0.08, $t = 6.00$, $p < .001$).
- Cognitive load negatively predicted vocabulary achievement ($\beta = -0.39$, SE = 0.08, $t = -4.88$, $p < .001$), whereas vocabulary learning strategies positively predicted achievement ($\beta = 0.60$, SE = 0.07, $t = 8.57$, $p < .001$).

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

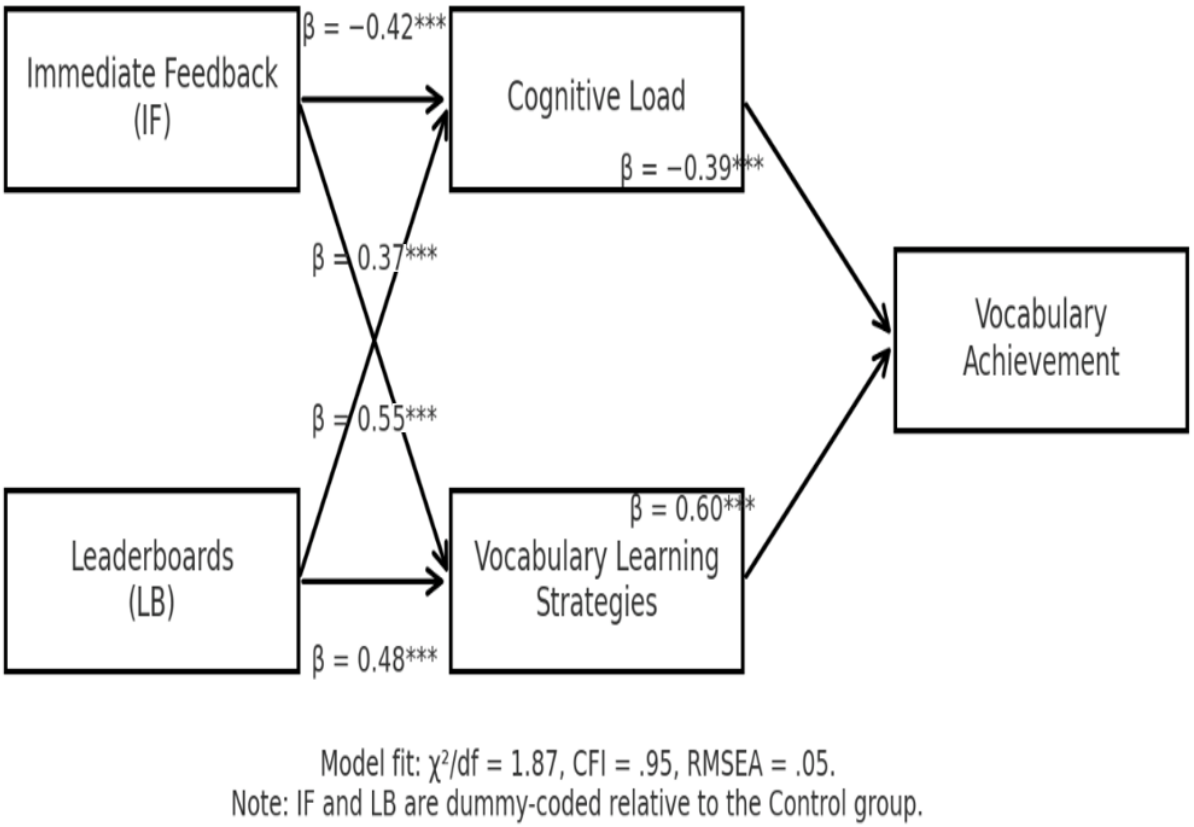

Figure 3.
Structural equation model linking gamified assessment features.

Table 3.
Standardized direct effects in the structural equation model.

From variable	To variable	β	SE	t
Immediate Feedback	Cognitive Load	−0.42	0.08	−5.25
Leaderboards	Cognitive Load	0.37	0.09	4.11
Immediate Feedback	Vocabulary Learning Strategies	0.55	0.07	7.86
Leaderboards	Vocabulary Learning Strategies	0.48	0.08	6
Cognitive Load	Vocabulary Achievement	−0.39	0.08	−4.88
Vocabulary Learning Strategies	Vocabulary Achievement	0.6	0.07	8.57

Note: All coefficients are standardized (β) and statistically significant at $p < 0.001$.

4.2.4. Qualitative Insights from Interviews

Qualitative data derived from semi-structured interviews provided additional depth and nuance to the quantitative findings. Participants consistently reported that immediate feedback reduced anxiety and strengthened their sense of self-efficacy during online vocabulary quizzes. They described feeling more in control of their learning process when they could see right away whether their responses were correct and why, which in turn facilitated more efficient cognitive processing and more deliberate use of vocabulary learning strategies. These interview accounts echo the SEM results, in which immediate feedback was associated with lower perceived cognitive load and more frequent strategic vocabulary learning.

In contrast, learners' experiences with leaderboards were more mixed and highlighted the dual-edged nature of competitive gamification features. On the one hand, several participants emphasized that seeing their rank and points in real time made the quizzes more engaging and encouraged them to

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

put in extra effort, adjust their study plans, and aim for higher scores. On the other hand, many participants also reported heightened anxiety, pressure, and worry about falling behind their peers when exposed to leaderboard rankings. These emotionally ambivalent responses align closely with the quantitative finding that leaderboards increased cognitive load while still supporting the use of vocabulary learning strategies, reinforcing the interpretation that leaderboards can simultaneously motivate and strain learners in online Chinese vocabulary learning.

4.3. Discussions

This study contributes both theoretically and practically by clarifying how immediate feedback and leaderboards function as distinct gamification features in online Chinese vocabulary learning. Theoretically, the findings extend cognitive load theory to a gamified online context by showing that specific design elements can either alleviate or exacerbate learners' perceived mental effort [8]. Practically, the results provide actionable guidance for optimizing instructional design in line with recent work on gamified language learning [7, 13]: immediate feedback emerged as a robust means of reducing cognitive load and enhancing strategic learning behaviors, whereas leaderboards appear beneficial only when carefully contextualized to avoid excessive cognitive strain.

The study deepens theoretical understanding by distinguishing the cognitive and motivational pathways associated with immediate feedback. Immediate feedback proved particularly valuable in that it was linked to reduced perceived cognitive load and more frequent strategic vocabulary learning, and these variables, in turn, were positively associated with vocabulary retention and overall academic performance within the structural model. Qualitative interview data reinforced this pattern, with students describing immediate feedback as anxiety-reducing, confidence-building, and helpful for monitoring their own learning. Taken together, these findings enrich cognitive load theory by illustrating how timely, constructive feedback can both manage cognitive resources and catalyze strategic engagement in online learning environments.

Conversely, leaderboards simultaneously elevated cognitive load, likely due to competitive pressures, while still exerting a positive influence on motivation and strategic learning behaviors. Interviewees' descriptions of feeling both energized and stressed by the rankings mirror this dual pattern and highlight the emotionally ambivalent nature of competitive gamification. This combination of quantitative and qualitative evidence underscores the complexity of social comparison mechanisms in gamified environments and provides more nuanced insights into motivational theories that emphasize both the energizing and taxing aspects of competition. Consequently, the findings point to the need for a balanced, context-sensitive approach to incorporating leaderboards so that they motivate students without overwhelming them.

From a practical standpoint, educators and instructional designers are encouraged to make systematic use of immediate feedback in online courses to support students' cognitive processing and learning efficiency. Leaderboards, although potentially beneficial for engagement and strategy use, should be implemented with caution and attention to learners' differing competitive orientations, anxiety levels, and stress thresholds. Overall, this study offers concrete recommendations for leveraging specific gamification elements to optimize vocabulary acquisition and cognitive engagement in online language education.

5. Conclusion

In conclusion, this research systematically examined the differential impact of immediate feedback and leaderboards on cognitive load, vocabulary learning strategies, and vocabulary achievement in an online Chinese language learning setting. Overall, immediate feedback proved particularly beneficial, as it substantially reduced cognitive demands while simultaneously fostering more frequent and systematic use of vocabulary learning strategies, which together contributed to higher post-test performance. Leaderboards, while promoting motivation and strategy optimization through competitive dynamics, concurrently increased cognitive load, necessitating thoughtful, context-sensitive implementation.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

Educators should prioritize integrating immediate feedback into online Chinese language courses and carefully tailor leaderboards based on learner characteristics. Future studies should conduct longitudinal and cross-cultural analyses to explore the role of learner-specific differences.

5.1. Recommendations

Based on the research conclusion from which some recommendations are derived, this study illuminated critical insights. First, prioritize immediate feedback. Educators should consistently use immediate feedback in online language instruction, focusing on formative assessments to foster learner autonomy and reduce cognitive load.

Second, contextualized use of leaderboards. Leaderboards should be utilized selectively, with adequate learner support and clear communication to minimize stress and maximize motivational benefits.

Third, personalized gamification. Adaptive gamification strategies that account for individual student differences (e.g., competitive orientation, anxiety levels) should be explored to optimize learning outcomes.

5.2. Limitations and Future Directions

Despite providing clear empirical insights into the distinct effects of immediate feedback and leaderboards on cognitive load and vocabulary learning strategies in online Chinese learning environments, this study still has several limitations that future research should address.

First, the relatively small sample size (N = 60) limits the generalizability of the findings. Although a path model with five observed variables can be estimated with this sample size, it still falls below many conventional recommendations for covariance-based SEM. Future research could replicate this study with a larger and more diverse sample to enhance external validity and improve the robustness of the model estimates. Additionally, because the structural model specified that the effects of immediate feedback and leaderboards on vocabulary achievement operated only through cognitive load and vocabulary learning strategies and did not include direct paths from the gamification conditions to achievement, future work should estimate alternative models that incorporate direct and indirect effects simultaneously and use bootstrap procedures to assess the robustness of indirect paths.

Second, the intervention period was restricted to six weeks. While sufficient to observe immediate effects, this timeframe may not capture longer-term effects or potential adaptation of students' learning behaviors. Further longitudinal studies spanning a semester or an academic year could provide richer insights into the sustained impacts of gamified features.

Third, this study was conducted within a single cultural and educational context (Chinese university learners). Future research could employ cross-cultural comparisons to investigate whether the effects of immediate feedback and leaderboards vary across educational systems, cultures, and learner characteristics.

Addressing these limitations will deepen understanding and further enhance the effectiveness of gamified interventions in language education contexts.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Acknowledgments:

The authors felt greatly appreciated by the teachers in this faculty who supported and helped during the study and experimental procedure for their understanding and selflessness.

© 2026 by the authors; licensee Learning Gate

Copyright:
© 2026 by the authors. This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

References
[1] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness: Defining" gamification"," in *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, 2011.
[2] J. Hamari, J. Koivisto, and H. Sarsa, "Does gamification work?--a literature review of empirical studies on gamification," in *2014 47th Hawaii International Conference on System Sciences (pp. 3025-3034). Ieee*, 2014.
[3] K. Seaborn and D. I. Fels, "Gamification in theory and action: A survey," *International Journal of Human-Computer Studies*, vol. 74, pp. 14-31, 2015. https://doi.org/10.1016/j.ijhcs.2014.09.006
[4] K. M. Kapp, *The gamification of learning and instruction: Game-based methods and strategies for training and education*. CA: Pfeiffer, 2012.
[5] R. Smiderle, S. J. Rigo, L. B. Marques, J. A. Peçanha de Miranda Coelho, and P. A. Jaques, "The impact of gamification on students' learning, engagement and behavior based on their personality traits," *Smart Learning Environments*, vol. 7, p. 3, 2020. https://doi.org/10.1186/s40561-019-0098-x
[6] Z. Zainuddin, M. Shujahat, and H. Haruna, "Gamified assessment in higher education," *Interactive Learning Environments*, vol. 28, no. 2, pp. 147–165, 2020.
[7] C. S. Chai and P. Y. Lin, "Gamification in language education: A systematic review," *Educational Technology Research & Development*, vol. 71, no. 2, pp. 429–452, 2023.
[8] J. Sweller, "Cognitive load theory and educational technology," *Educational Technology Research and Development*, vol. 68, pp. 1-16, 2020. https://doi.org/10.1007/s11423-019-09701-3
[9] J. Van Merriënboer and J. Sweller, "Cognitive load theory in health professional education," *Design Principles and Strategies*, vol. 44, no. 1, pp. 85–93, 2010.
[10] L. Ding, E. Er, and M. Orey, "Impact of gamification on learners' cognitive load," *Computers & Education*, vol. 120, pp. 213–226, 2022.
[11] J. Hattie and H. Timperley, "The power of feedback," *Review of Educational Research*, vol. 77, no. 1, pp. 81-112, 2007. https://doi.org/10.3102/003465430298487
[12] H.-T. Hung, J. C. Yang, G.-J. Hwang, H.-C. Chu, and C.-C. Wang, "A scoping review of research on digital game-based language learning," *Computers & Education*, vol. 126, pp. 89-104, 2018. https://doi.org/10.1016/j.compedu.2018.07.001
[13] C. Johannes and A. Haase, "The impact of feedback mode on learning gain and self-efficacy: A quasi-experimental study," *Active Learning in Higher Education*, vol. 25, no. 3, pp. 391-407, 2024. https://doi.org/10.1177/14697874221131970
[14] Z. Yu, Y. Zhu, and L. Chen, "Effects of gamification on language learners' self-regulation," *Journal of Educational Computing Research*, vol. 60, no. 6, pp. 1298–1323, 2022.
[15] L. Festinger, "A theory of social comparison processes," *Human Relations*, vol. 7, no. 2, pp. 117-140, 1954. https://doi.org/10.1177/001872675400700202
[16] M. Sailer, J. U. Hense, S. K. Mayr, and H. Mandl, "How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction," *Computers in Human Behavior*, vol. 69, pp. 371-380, 2017. https://doi.org/10.1016/j.chb.2016.12.033
[17] R. N. Landers, K. N. Bauer, and R. C. Callan, "Gamification of task performance with leaderboards: A goal setting experiment," *Computers in Human Behavior*, vol. 71, pp. 508-515, 2017. https://doi.org/10.1016/j.chb.2015.08.008
[18] R. S. Alsawaier, "The effect of gamification on motivation and engagement," *The International Journal of Information and Learning Technology*, vol. 35, no. 1, pp. 56-79, 2018. https://doi.org/10.1108/IJILT-02-2017-0009
[19] E. L. Deci and R. M. Ryan, "The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior," *Psychological Inquiry*, vol. 11, no. 4, pp. 227-268, 2000. https://doi.org/10.1207/S15327965PLI1104_01
[20] A. Domínguez, J. Saenz-de-Navarrete, L. De-Marcos, L. Fernández-Sanz, C. Pagés, and J.-J. Martínez-Herráiz, "Gamifying learning experiences: Practical implications and outcomes," *Computers & Education*, vol. 63, pp. 380-392, 2013.
[21] R. L. Oxford, *Language learning strategies: What every teacher should know*. Boston: Heinle & Heinle, 1900.
[22] I. S. P. Nation, *Learning vocabulary in another language*. Cambridge, UK: Cambridge University Press, 2001.
[23] Y. Gu and R. K. Johnson, "Vocabulary learning strategies and language learning outcomes," *Language Learning*, vol. 46, no. 4, pp. 643-679, 1996.
[24] N. Schmitt, *Vocabulary learning strategies. In N. Schmitt & M. McCarthy (Eds.), Vocabulary: Description, acquisition and pedagogy*. Cambridge, UK: Cambridge University Press, 1997.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate

[25] B. Nguyen-Viet and H. Doan Ngoc Minh, "How gamification enhances learning effectiveness through blended learning and intrinsic motivation: The moderating effects of self-regulation," *Sage Open*, vol. 15, no. 4, p. 21582440251385846, 2025. https://doi.org/10.1177/21582440251385846

[26] S. G. Hart and L. E. Staveland, "Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. A. Hancock & N. Meshkati (Eds.)," *Human Mental Workload Advances in Psychology*, vol. 52, pp. 139–183, 1988.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 366-378, 2026
DOI: 10.55214/2576-8484.v10i2.12079
© 2026 by the authors; licensee Learning Gate