Crossword Puzzles for Pinyin-Based Chinese Vocabulary Retention

[1]Jenny Yap Tze Kie, [*2]Leona Kiu King Chieh, [3]Loh Siaw San, [4]Ting Hie Ling (Dr.)

[1,3] Akademi Pengajian Bahasa, UiTM Cawangan Sarawak, Kampus Samarahan

[2] Akademi Pengajian Bahasa, UiTM Shah Alam

[4] Akademi Pengajian Bahasa, UiTM Cawangan Sarawak, Kampus Mukah

***Corresponding Author**

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ABSTRACT

Vocabulary retention remains one of the major challenges for learners at the early stage of Chinese language learning. Exploring alternative instructional strategies is necessary to tackle the challenge of limited orthographic reinforcement, especially third language learners who rely primarily on Pinyin rather than Chinese characters. This concept paper proposes the use of crossword puzzles as an interactive learning activity to support vocabulary retention among university students enrolled in introductory Chinese language courses. By combining semantic clues with Pinyin-based lexical retrieval, the proposed crossword activities encourage learners to actively recall and reinforce newly learned vocabulary in a meaningful learning context. The proposed study adopts a quasi-experimental research design comprising a pre-test, an immediate post-test, and a delayed post-test to examine vocabulary retention over time. Students participating in Pinyin-based crossword learning activities will complete vocabulary assessments at different stages, allowing changes in vocabulary retention to be examined across the intervention period. The findings of the proposed study are expected to provide empirical evidence on the use of crossword puzzles in Pinyin-based Chinese vocabulary instruction. The study may also offer practical pedagogical implications for improving vocabulary learning among beginner learners and contribute to the development of more engaging instructional strategies for Chinese as a third language.

Keywords: crossword puzzles，pinyin-based Chinese vocabulary，game-based learning

INTRODUCTION

For non-native learners, mastering the pronunciation and recognizing the Chinese characters are challenging due to Standard Chinese's tonal nature and logographic script (Wang & Han, 2021). Hanyu Pinyin is crucial in addressing the difficulties created by Chinese logographic characteristics. It serves as a cognitive link that assists in learning pronunciation, lower cognitive demands, and enhances character acquisition. Nonetheless, conventional teaching approaches often depend heavily on memorization and repetitive practice. These traditional approaches potentially reduce learners' engagement and increase cognitive load (Sweller, 2020). Conventional learning strategies frequently focus on rote memorisation to enhance vocabulary (Ma, 2012). This passive approach does not involve multisensory or significant engagement which may reduce its efficacy for long-term retention and contextual application (Enriquez et al., 2026). Traditional methods rely heavily on teachers' resources which limit opportunities for collaboration or autonomous learning (Sivahar et al., 2025; Ma, 2012). Learning by only depending on teachers' resources may overlook personal learning needs and be less adaptable to diverse learner profiles (Sivahar et al., 2025). Furthermore, the repetitive and correction-focused characteristics of traditional methods can increase learners' anxiety. This emotional stress can negatively result in motivation and learning performance.

Aligned with modern educational teaching approaches, game-based learning has been shown to improve learners' motivation and engagement which consequently contribute to better academic performance (Yang, 2025; Ting

& Lam, 2021; Tambaritji & Atmawidjaja, 2020). While the educational market is flooded with various Chinese language learning games and applications, beginners are often overwhelmed by too many choices, leading to cognitive overload.

The proposed Pinyin-based crossword puzzles are designed to serve a dual purpose: optimizing orthographic-to-phonological mapping and fostering long-term vocabulary retention. Gamified learning strengthens the cognitive pathways responsible for lexical retrieval in Chinese by systematically scaffolding challenges (Perfetti & Harris, 2013). This Pinyin-based crossword puzzle game is aligned with the official curriculum matrix and pedagogical syllabi of a target public university's Chinese language program. It not only directly reinforces institutional learning outcomes but also effectively mitigates the alignment gaps common in generalized software, positioning this tool as an indispensable pedagogical scaffold for student success.

To illustrate the proposed intervention, Figure 1 presents a sample of the Pinyin-based crossword puzzle.

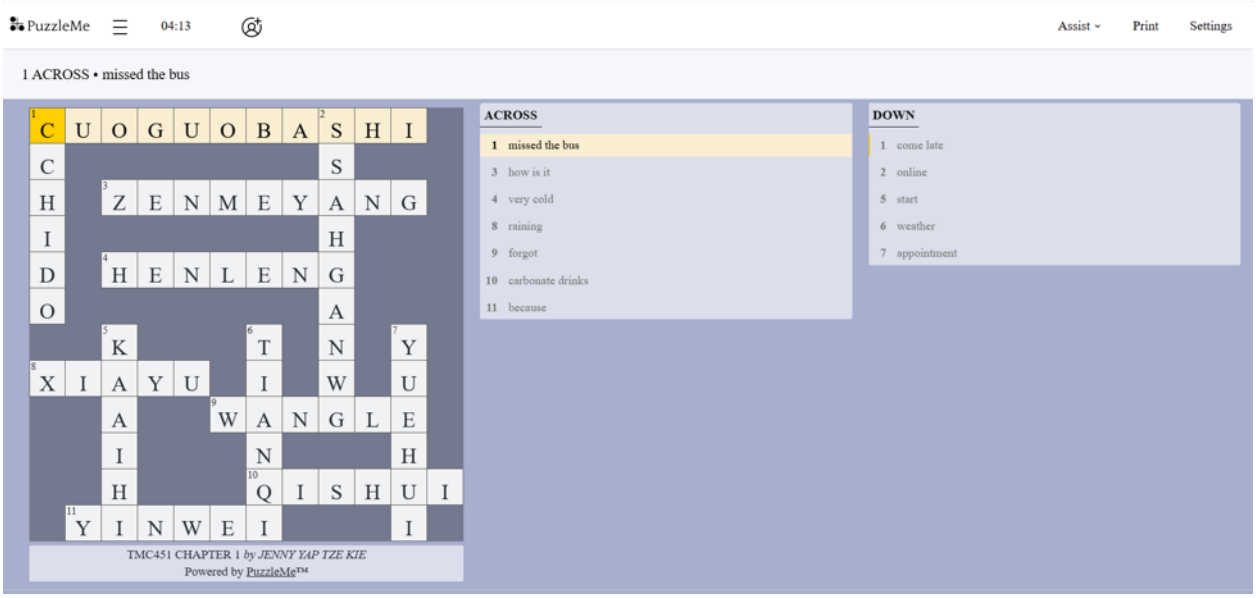

Figure 1. Example of a Pinyin-based crossword puzzle item

As demonstrated in Figure 1, the creation of crossword puzzles with Chinese Pinyin seeks to alleviate the tedium of conventional teaching methods and markedly enhance student engagement through an enjoyable, instructive format. While students engage with the puzzles, they must consistently recall, articulate, and construct Pinyin syllables; this procedure quietly enhances their foundational retention of the sounds and significations of Chinese vocabulary, significantly advancing their proficiency in the language. Conventional crossword puzzles predominantly utilize English or Chinese characters, seldom emphasizing Pinyin, which may be daunting for novices with restricted character familiarity. Pinyin-based crossword puzzles, however, diminish the entry barrier, offering an inviting and gratifying foundation for novices.

From an academic standpoint, there are two fundamental reasons for implementing these Pinyin-based spelling games. First, they enhance the relationship between phonological awareness and orthography. Pinyin serves as an essential phonetic notation system; spelling games facilitate the accurate differentiation of initials and finals, thereby minimizing spelling errors. Secondly, they promote "elaborative rehearsal," a principle derived from cognitive neuroscience. In contrast to rote memorization, these games and puzzles necessitate active semantic retrieval and logical reasoning, fostering deeper cognitive engagement that strengthens neuronal memory connections and improves long-term memory retention.

Furthermore, transitioning this game to a digital online platform enables students to engage in study and play at their convenience, regardless of location. The online medium offers numerous academic and practical advantages:

- Immediate Feedback and Adaptive Correction: The online technology notifies students of inaccuracies upon inputting Pinyin. This "immediate reinforcement" prevents the establishment of erroneous patterns and is more pedagogically relevant than paper-based assignments that necessitate a teacher's delayed evaluation.

- Data-Driven Learning and Customized Recommendations: Digital platforms assess response velocity and error frequencies. This data enables educators or the system to generate customized "error logs" or targeted puzzles for students, facilitating personalized instruction.

- Multimodal Engagement and Gamified Motivation: The online platform integrates animations and gamification features such as leaderboards and achievement badges. Simultaneous auditory and visual stimulation enhances diverse learning modalities and intrinsic motivation.

LITERATURE REVIEW

Experimental designs in game-based vocabulary retention

Studies on game-based vocabulary retention consistently utilise several experimental designs to assess vocabulary learning performance. A primary methodological framework namely quasi-experimental design which consists of divided participants into experimental groups (EG) and control groups (CG) are widely used in game-based vocabulary retention studies. The participants were divided into EG undergo gamified interventions and CG receive standard instruction with the aim to compare the impacts of different interventions. For example, Ahmed et al. (2022) evaluating the effectiveness of using Kahoot on 50 intermediate learners. Learners were randomly assigning them to an EG that experienced gamification and a CG that received conventional teaching. After ten sessions of treatments, immediate and three weeks delayed post-tests showed notable differences in vocabulary recall and retention favoring the gamified group. In a similar vein, Patra et al. (2022) examined a group of 50 primary school students' acquisition of 90 target words through nine sessions with an engaging computerized game. Similar to the findings of Ahmed et al. (2022), both the immediate and three weeks delayed post-tests revealed that the experimental group notably exceeded the traditional instruction control group in terms of immediate recall and long-term retention.

Mixed methods approach integrates both quantitative and qualitative data to offer a thorough understanding. For instance, the impact of Outdoor Experiential learning (OEL) was assessed through pre-post-tests and qualitative interviews to measure vocabulary retention and students' perceptions (Mariappan, 2025). Furthermore, to reflect the complex aspects of vocabulary acquisition, modern approaches have combined mixed-method techniques with advanced sensing frameworks. Several scholars (Zhang et al., 2023; Yu & Tsuei, 2023) have started measuring learner engagement through behavioural, cognitive, and emotional aspects using sophisticated tracking tools like Tobii eye-trackers and wearable electroencephalographic (EEG) sensors to link real-time attention trends with vocabulary performance scores. Moreover, modern designs more frequently base their approaches on Cognitive Load Theory (CLT). Approaches that enhance the context of Digital based vocabulary learning activities particularly by decreasing element interactivity and search requirements to lessen cognitive overload, resulting in higher and more consistent incidental vocabulary learning (IVL) retention scores than those seen in unoptimized digital game settings.

Empirical Implementations of Game-Based Learning

Bouzaiane and Youzbashi (2024) extended their study to higher education contexts by monitoring 80 foundation-level students across four different class levels in Oman. Participants engaged with ten English vocabulary words for each level through Kahoot and Wordwall games. The testing timeline lasted six weeks, including a pre-test, a post-test, and a retention test, along with a questionnaire after the post-test. The data validated significantly favourable learner attitudes and notable enhancements in vocabulary retention, irrespective of gender or proficiency level. Focusing on more advanced media variations, Alhazmi (2024) carried out a quasi-experimental study involving 50 university students to assess the growth of academic vocabulary by evaluating multimedia methods that integrate text, images, sound, and video alongside traditional text-based technique. Findings revealed that multimedia teaching resulted in much greater vocabulary improvements on the immediate assessment and long-term retention.

While previous studies have largely focused on generic digital platforms like Kahoot or Wordwall for European languages, recent attention has also been directed toward specialized crossword applications. For example, Mok et al. (2023) investigated the efficacy of the Mandarin Endocentric Phrases Crossword Puzzle (MEPCP), an online game-based tool designed to teach complex syntactic structures. Utilizing a quantitative survey, their findings demonstrated that the interactive crossword format significantly enhanced student's effectiveness in learning, yet entertaining. Crucially, the researchers highlighted that the MEPCP allows learners to actively experience linguistic content and receive immediate feedback in a learner-centred, engaging environment. The integration of such a framework not only improves students' communicative skills but also provides empirical validation for using crossword mechanics to support Mandarin acquisition.

Beyond Mandarin pedagogy, the strategic utilization of crossword puzzles has gained widespread empirical support for its capacity to enhance general vocabulary mastery across diverse EFL settings (Tambaritji & Atmawidjaja, 2020; Yang, 2025). For instance, Yang (2025) conducted a quasi-experimental study among EFL majors at a junior college in Taiwan, integrating crossword puzzles with mnemonics in comparison to traditional lecture-based learning. The findings showed significant inter-group differences, favouring experimental group (crosswords with mnemonics) compared to traditional lecture-based control groups in vocabulary outcomes. Crucially, Yang noted that this pedagogical synergy is vital when the learners' L1 and L2 belong to drastically different language families—such as Mandarin and English—where lexical acquisition poses higher cognitive barriers. By extension, Yang's (2025) evidence supports that crossword tasks can effectively mitigate the linguistic distance between language systems. This provides a justification for the current study, which applies crossword mechanics to help non-native learners navigate the phonological structures of Pinyin-based Chinese.

Past studies above revealed that majority of existing vocabulary retention studies utilized quasi-experimental designs to examine the impact of game-based vocabulary learning on retention. This methodological approach is appropriate in educational environments where randomly assigning participants is frequently impractical due to the establishment of classroom arrangements. Thus, this current study suggests a quasi-experimental design that includes pre-test, immediate post-test, and delayed post-test in order to allow the researcher to assess shifts in vocabulary knowledge at various phases of learning and retention. Including a delayed post-test is crucial for assessing whether crossword puzzle activities lead to lasting vocabulary retention instead of just short-term learning improvements.

DISCUSSION

This concept paper suggests that crossword puzzle activity can serve a cognitive support function for individuals who are new to Chinese vocabulary and have had little or no exposure to the written form of the character. If learners have not been taught or have not yet acquired knowledge pertaining to orthographic forms of the characters, the potential will exist for a weakened foundation on which to develop stable lexical representations. The result of the failure to establish a solid foundation could result in difficulties later, throughout the long-term retention of vocabulary items.

Building upon the theoretical frameworks discussed above, the practical value of the proposed gamified framework becomes evident when compared to traditional methods. Table 1 summarizes the key pedagogical shifts.

Aspect	**Traditional Rote Drill**	**Pinyin-Based Crossword Puzzle**
Learning process	Repetition and memorization of vocabulary items	Retrieval and problem-solving through clues
Cognitive processing	Mainly involves passive recognition and memorization	Encourages active recall and meaningful processing
Learner engagement	Teacher-centred and repetitive practice	Learner-centred and interactive learning

Learner emotion	May increase anxiety due to fear of making mistakes and repeated correction	Provides a lower-pressure learning environment through game-based interaction
Vocabulary retention	Supports short-term recall through repeated exposure	Promotes repeated retrieval for stronger vocabulary retention

Table 1. Comparison between Traditional Rote Drill and Pinyin-Based Crossword Puzzle Learning

As shown in Table 1, Pinyin-based crossword puzzles provide additional cognitive and emotional support by encouraging active retrieval, interaction, and a less anxiety-provoking learning environment. Previous research has also demonstrated the potential of crossword puzzles. Mok et al. (2023) developed the Mandarin Endocentric Phrases Crossword Puzzle (MEPCP) and found that the interactive crossword format enhanced learners' engagement and effectiveness in learning Mandarin. Therefore, the present study proposes Pinyin-based crossword puzzles as a supplementary approach to reinforce vocabulary retention rather than replace traditional vocabulary instruction.

Theoretical Implications

Utilizing Cognitive Load Theory (Sweller, 2020) as a framework for examining the cognitive processing involved in crossword puzzles as tasks that provide structured support helps to aid in the reduction of extraneous cognitive load. It further states that providing structured tasks will limit the number of potential lexical options available and allow the learner to have retrieval cues that are explicitly defined, thus making it easier for the learner to retrieve phonological and semantic information from their memory. Therefore, instead of relying solely on the method of rote memory, learners are required to access multiple sources of information (i.e., phonological and semantic). The shift in learner behaviour may promote greater levels of processing within the individual for the vocabulary items. Further research is required to examine the strength of this proposition.Also, crossword puzzle activity cannot be used as a substitute for traditional vocabulary instruction; however, it can be used, in addition to traditional vocabulary instruction to facilitate another method for reinforcing vocabulary without traditional orthography.

Pedagogical Implications

The impact of Game Based Learning on improving motivation and sustaining interest has been documented in previous research (Hamari et al., 2014; Sailer & Homner, 2020) When examining the potential for adapting GBL activities that focus on the teaching of Pinyin-based Chinese vocabulary however, there are very few studies/analyses performed specifically to demonstrate that these types of adaptive strategies can be used effectively in this context.

Crossword puzzles may provide an alternative structure for learning through repetition; allowing students to engage in a meaningful way within the cognitive construct of word recognition/learning due to the nature of crossword design. In addition, crossword tasks are an effective way of encouraging students to employ their word recognition skills through lexical knowledge while using context/semantics for retrieval.

Additionally, this type of design is consistent with Krashen's Affective Filter Hypothesis (1982) as GBL may reduce anxiety and help create a more nurturing and supportive environment for the learner. Yang (2025) and Mok et al. (2023) note that processing phonological systems which are not currently used in a learners L1 may cause anxiety for many students. Therefore, the use of interactive tasks may minimize both cognitive and emotional overload.

METHODOLOGICAL IMPLICATIONS

The design features a quasi-experimental structure with a pre-test, immediate post-test, and delayed post-test. Previous gamification methods have only been used to measure short term performance. A quasi-experimental design will permit researchers to measure vocabulary retention over time.Using the performance of learners during each of the tests may provide researchers with a means to understand how learning crossword puzzles

influence memory retention and retrieval stability. The delayed post-test will help researchers measure whether gains in vocabulary remain after the immediate recall period. The quasi-experimental model has not yet been tested, but it will serve as a structural basis for future research.

Proposed Methodology

To empirically evaluate the pedagogical efficacy of the proposed syllabus-aligned Pinyin-based crossword puzzles, this study adopts a systematic, mixed-methods framework. The methodology is designed to measure both the cognitive outcomes (Pinyin orthography and long-term vocabulary retention) and the user experience (mitigation of cognitive overload) compared to generalized commercial software.

The study employs a quasi-experimental, pre-test/post-test control group design, supplemented by qualitative survey data. This mixed-methods approach allows for a comprehensive assessment of the intervention. The experimental group will engage with the targeted Pinyin-based crossword puzzles, while the control group will utilize standard, unaligned vocabulary drilling applications. This design isolates the variables of "systematic scaffolding" and "curriculum alignment" to determine their specific impact on phonetic lexical retrieval.

The target population consists of novice Chinese language learners (N = 160) currently enrolled in an introductory Mandarin course at a designated public university. Participants will be recruited using purposive sampling to ensure a uniform baseline proficiency (e.g., zero or minimal prior exposure to Mandarin). By selecting students within this specific institutional context, the study ensures that the targeted learning outcomes of the sample perfectly align with the curriculum matrix upon which the crossword puzzles were developed.

Data collection will be facilitated through three primary instruments, each designed to capture distinct dimensions of the learning process:

- The Pedagogical Intervention Tool: The custom-developed Pinyin-based crossword application. The tool features systematically scaffolded difficulty levels that mirror the university's pedagogical syllabus, ensuring learners are exposed to targeted vocabulary without experiencing extraneous cognitive load.

- Linguistic Assessments (Pre-, Post-, and Delayed Post-tests): Standardized diagnostic tests designed specifically to measure accuracy in Pinyin orthography (strictly excluding Chinese characters and tone marks). The assessments evaluate learners' ability to accurately retrieve the correct alphabetic spelling for the target vocabulary based on phonemic awareness. A delayed post-test, administered 14 weeks after the intervention, will specifically evaluate long-term vocabulary retention in its purely phonetic form.

- Cognitive Load and Engagement Questionnaire: A post-intervention survey utilizing a Likert-scale format, adapted from established Cognitive Load Theory frameworks (Paas, 1992). This instrument aims to quantify learners' perceived cognitive overload and assess their engagement levels compared to their prior experiences with generalized language learning apps.

The implementation of the proposed empirical study will proceed through four distinct phases over a projected duration of 14 weeks:

- Phase 1: Baseline Assessment (Week 1): Upon obtaining informed consent, all novice learners will complete a demographic survey and an initial pre-test. This phase aims to establish a clear baseline regarding their phonetic spelling proficiency and verify their minimal prior exposure to Mandarin.

- Phase 2: Pedagogical Intervention (Weeks 2 to 12): The sample will be divided into the experimental and control groups. The experimental group will integrate the custom Pinyin-based crossword puzzles into their weekly study regimen for 20 minutes per session. Concurrently, the control group will study the exact same vocabulary sets using traditional, non-gamified rote drilling methods. Both groups will adhere strictly to identical syllabus content to isolate the variable of gamified scaffolding.

- Phase 3: Immediate and Delayed Evaluation: Immediately following the intervention period, both groups will complete the post-test to evaluate short-term gains in alphabetic Pinyin orthography. To accurately measure the gamified framework's impact on long-term vocabulary retention, a delayed post-test will be administered unannounced in Week 14.

- Phase 4: Qualitative Feedback Integration: In the final phase, participants in the experimental group will complete the Cognitive Load and Engagement Questionnaire. Furthermore, a purposive subset of participants (n = 30) will be invited for semi-structured interviews. This qualitative data will provide deeper pedagogical insights into how structured play facilitated their mastery of foundational phonetics and accurate alphabetical spelling, while effectively mitigating cognitive overload.

Limitations and Future Directions

There are several limitations to be noted. First and foremost, the proposed method has not gone through an empirical evaluation, therefore any prediction about the effectiveness of the new procedure has no empirical backing and all evidence to support the method's success is strictly theoretical currently. Second, the issue of orthographic differences comes to the forefront of this research. The current research is exclusively based upon learners in a Pinyin-based learning environment therefore the findings may not be generalizable to environments wherein learners have access to Chinese characters, since orthographic processing could have an impact on the cognitive pathways associated with the learning process. Further research could be conducted to replicate this work using the proposed experimental design within a real classroom setting. Additionally, more finely granulated data collection methods such as eye-tracking or EEG recording could be used to explore students' level of cognitive engagement during the completion of the crossword tasks. This type of evaluation may provide further insight into how cognitive effort is allocated and how the effort of processing is distributed during the retrieval of vocabulary.

CONCLUSION

The study presents an innovative approach to using crossword puzzles to supplement the teaching and learning of Pinyin and vocabulary in Chinese. This approach addresses the problem of the very limited amount of orthographic support for beginning students of Chinese who learn to read primarily using Pinyin. Crossword puzzles can complement existing instruction rather than replace current methods. This will create opportunities for learners to use vocabulary through active retrieval and multiple exposures in a structured manner. The study relied on several theories that are recognized within the cognitive processing, affective factors, and gamification literature. However, there has yet to be empirical evidence on the impact that crossword puzzles will have as an instructional tool in sustained vocabulary retention. Ultimately, this paper provides a general framework for incorporating structured game-based activities into Chinese language instruction for beginning students, but also a foundation for future research on how students learn with Pinyin form and retain their vocabulary knowledge after being exposed to reading in an environment with limited orthography.

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