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Investigating the Impact of AI Generated Mnemonic Illustrations on Learning Japanese Kanji

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Abstract: Learning Japanese Kanji presents a significant challenge for novice learners due to the vast number of characters, their visual complexity, and a lack of relatable learning resources. While various strategies exist, the use of illustrations in Kanji learning, despite their proven benefits, remains underexplored. This study investigates the impact of integrating AI-generated mnemonic illustrations with textual mnemonics on learners' Kanji attainment, cognitive workload, and learning attitudes. In a quasi-experimental study with novice learners, a control group using only text-based mnemonics was compared against experimental groups that used AI-generated illustrations. Quantitative analysis, corroborated by qualitative data, revealed that while the illustrations did not produce a statistically significant improvement in post-test scores, they had a significant positive impact on reducing the perceived cognitive workload. This indicates that despite theoretical support for improved learning outcomes when adding images to text, this principle may not directly enhance recall for logographic languages like Kanji. Nevertheless, the findings suggest that while AI-generated illustrations may not directly boost short-term recall, they effectively make the learning process less cognitively demanding.

Keywords: Japanese Kanji, Mnemonic Illustrations, Kanji Learning Strategies, Cognitive Workload, Learning Attitude, Generative AI

1. Introduction

Kanji, one of three Japanese writing systems, is crucial for achieving literacy in the Japanese language (Hiraga, 2006). The global popularity of learning Japanese has surged, with over 3.7 million learners worldwide facing the challenge of mastering Kanji's vast character set, visual complexity, and a scarcity of tailored learning resources (Japan Foundation, 2021; Shekarabi & Tajfirooz, 2023). While learners employ various strategies such as mnemonics, morphological analysis, and context-based learning (Mori & Shimizu, 2007), many existing methods underutilize illustrations. This is a notable omission, given that cognitive theories like Dual Coding Theory (Paivio, 1986; Patel, 2023) and the Cognitive Theory of Multimedia Learning (Mayer, 2024) suggest that combining images with text enhances memory and understanding.

Mnemonic strategies are particularly suitable for novices but can fail when the mnemonic itself is abstract, causing learners to forget the Kanji's meaning (Rose, 2013). This can increase cognitive workload and negatively impact student attitudes (Sweller, 2023). To address this, our study combines mnemonics with mnemonic illustrations, which visually represent key concepts to make them more concrete. Manually creating such illustrations is not only time-consuming but also fails to cater to diverse learners. This research utilizes text-to-image Generative AI (GenAI), which facilitates the creation of personalized mnemonic illustrations, allowing learners to connect with visuals that are culturally and personally relevant. This study investigates the impact of these AI-generated illustrations on novice learners' Kanji attainment, cognitive workload, and attitudes, focusing specifically on the identification of Kanji meanings and not on the pronunciation or writing aspect of Kanji. The

findings offer tangible instructional strategies, empowering educators and students to co-create customized visual aids in the classroom that cater to diverse learning styles and backgrounds.

2. Related Work

Kanji consists of logographic characters that range from simple forms, such as 一 (meaning “one”) with a single stroke, to complex ones like 員 (meaning “member”) with multiple strokes (Seely & Henshall, 2016). Proficiency requires memorizing hundreds of these characters, and learners adopt a variety of strategies to achieve this. Mori and Shimizu (2007) identified six primary self-reported strategies: mnemonic strategies, morphological analysis, rote memorization, context-based learning, metacognitive strategies, and helplessness. Among these, mnemonic strategies are particularly effective for novice learners (Rasiban, 2016). Recent pedagogical innovations include Naritachi, which focuses on Kanji formation (Aneros et al., 2020), Cognitive Illustration based on formation processes (Sutedi & Juangsih, 2024), and gamification approaches (Sonjaya et al., 2024). Despite these advances, a gap remains in effectively leveraging illustrations, even though frameworks such as Dual-Coding Theory (Paivio, 1986) and the Cognitive Theory of Multimedia Learning (Mayer, 2024) suggest that integrating illustrations with text can improve learning outcomes.

Illustrations in education can be decorative, representational, organizational, or mnemonic, each serving a distinct role. Among these, mnemonic illustrations have demonstrated the strongest positive effects on text learning (Carney & Levin, 2002). They are designed with systematic mnemonic components to enhance recall, often through keyword integration, where important terms from the text are visually represented in a way that is relevant and meaningful within the learning context (Erlan, 2024; Carney & Levin, 2002; Levin, 1983). Personalization remains a challenge, as static resources such as Kanji Pict-O-Graphix (Rowley, 1992) cannot accommodate the diverse needs of learners. Generative AI (GenAI) offers a promising solution by enabling the creation of personalized mnemonic illustrations. Although research on GenAI for Kanji acquisition is still emerging, its potential is evident from applications such as visual storytelling (Han & Cai, 2023) and AI-assisted video production for Japanese learning (Takeda-Kolb & Ohsawa, 2024). This study addresses this gap by investigating the impact of AI-generated mnemonic illustrations on the learning outcomes of novice Japanese as a Foreign Language (JFL) learners. The research is guided by the following questions: (RQ1) How do AI-generated mnemonic illustrations impact JFL learners' attainment of Kanji characters?; (RQ2) What is the impact of AI-generated mnemonic illustrations on the cognitive workload experienced by JFL learners during Kanji learning?; and (RQ3) How do AI-generated mnemonic illustrations affect JFL learners' attitudes towards learning Kanji?

3. Learning Intervention (Kanji Quest)

The learning intervention, "Kanji Quest," involved a set of 40 Japanese Kanji characters selected based on specific criteria. To ensure variety, ten characters were chosen from each of the four main types (ideographic, pictographic, phonetic, combined ideographic) as defined by Hiraga (2006).

Table 1. *Selected Kanji characters for Kanji Quest*

Kanji Type	Simple Kanji	Complex Kanji
Ideographic	一, 四, 末, 下, 三, 上, 八, 二, 十	百
Pictographic	元, 月, 犬, 火	員, 見, 金, 雨, 会, 京
Phonetic	円, 千, 仕	時, 作, 思, 地, 気, 体, 社
Combined Ideographic	友, 北, 立, 父	料, 夜, 明, 歩, 旅, 名
Total	20	20

All Kanji were from JLPT levels N4 and N5, suitable for beginners. The set was balanced for difficulty, containing 20 "simple" Kanji (≤5 strokes) and 20 "complex" Kanji (6–10 strokes), as stroke count impacts learning difficulty (Matsunaga, 2016). A Japanese language expert validated the selection. The complete list of selected Kanji is presented in Table 1. A website, Kanji Quest, was developed in two versions to test the intervention. The first version presented the Kanji, its meaning, and a textual mnemonic adapted from Seely and Henshall (2016). The second version included the same information plus an AI-generated mnemonic illustration (as shown in Figure 1).

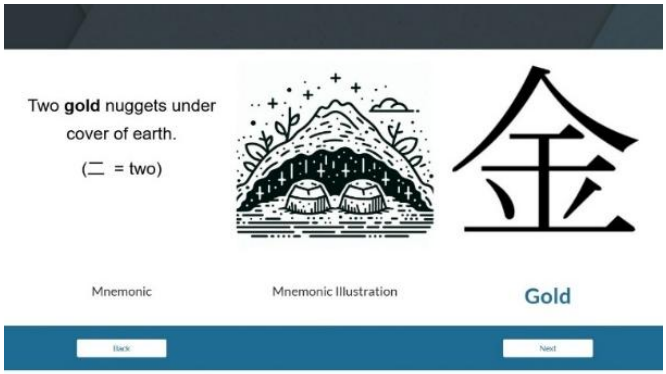

Figure 1. Depiction of the Kanji Quest interface.

These illustrations were produced in a two-step process. First, a custom tool, "Prompt Builder for Mnemonic Illustration" using the MistralAI API, converted mnemonics into structured text-to-image prompts based on prompt engineering guidelines (Garg et al., 2025; Garg & Rajendran, 2024). Second, these prompts were input into a Text-to-Image AI tool (MS CoPilot) to generate the final illustrations. Given the scale of the intervention, all illustrations were generated prior to the study. While not personalized for each individual in real-time, the prompts were specifically designed to create visuals that would be culturally and contextually relevant to the study's participant demographic. A Japanese language expert validated all resulting images for relevance and appropriateness. This approach ensured all students in the experimental groups viewed the same validated set of images.

4. Research Design and Data Collection

This study used a quasi-experimental design (Shadish et al., 2002) to compare three Kanji learning strategies. After obtaining ethical approval and student consent, 84 engineering undergraduate students (average age 20; 66 male, 18 female) with no prior Japanese knowledge were randomly assigned to one of three groups. The control group (Group M, n = 27) used only textual mnemonics. The first experimental group (Group MI, n = 26) used mnemonics with AI-generated illustrations. The second experimental group (Group MID, n = 31) used mnemonics, AI-generated illustrations, and also drew each Kanji character. The drawing component was included because writing activates sensorimotor systems, which has been shown to enhance learning and memory across age groups (Kontra et al., 2012; Macedonia, 2014). The overall research design, outlining the sequence of activities, is depicted in Figure 2.

Figure 2. Research Design.

The procedure began with a pre-test to assess participants' existing Kanji knowledge. Any student demonstrating prior knowledge was excluded. The remaining participants received a brief introduction to the Japanese language, followed by a 20-minute learning session using their assigned version of the Kanji Quest platform. Group M used a version

containing only mnemonics and Kanji characters, and participants were instructed to read the mnemonic and try to connect it to the meaning of the character. Group MI used a version of Kanji Quest (shown in Figure 1) that included illustrations alongside the mnemonics and Kanji. These participants were instructed to use both the mnemonic and the illustration to connect the Kanji character to its meaning. Group MID followed the same instructions as Group MI, but in addition, participants were asked to draw each Kanji character without concern for stroke order. After the learning session, participants were given a 15-minute break. They then completed a post-test, the NASA Task Load Index (NASA-TLX) survey to measure perceived cognitive workload (Hart & Staveland, 1988), and an Attitude Questionnaire (Mori & Shimizu, 2007; Shimizu & Green, 2002) to assess perceptions toward Kanji learning. Finally, semi-structured interviews were conducted with 11 students (M: 3, MI: 4, MID: 4) to gather qualitative insights. The semi-structured interviews explored three key areas: participants' learning strategies using the provided aids (illustrations, mnemonics, and drawing), the challenges they encountered, and their suggestions for improving the intervention.

Quantitative analysis was conducted on pre-test, post-test, NASA-TLX, and Attitude Questionnaire scores, with findings triangulated using data from semi-structured interviews. Kanji learning attainment was examined using Welch's ANOVA on post-test scores (total, simple, and complex items). The perceived cognitive workload was analyzed using Welch's ANOVA on weighted NASA-TLX scores, as the data met normality but not homogeneity of variance assumptions. Attitude scores were analyzed using a one-way ANOVA with Tukey's post-hoc test for dimensions meeting parametric assumptions (Total Score, Usefulness, Affective Orientation) and the Kruskal-Wallis test for non-parametric dimensions (Aptitude, Difficulty). To support and interpret the quantitative results, interview responses were analyzed using the selective coding method from content analysis (Mayring, 2015, p. 95).

5. Results

Post-test analysis showed no significant difference in Kanji learning attainment among the three groups (M, MI, and MID) for total scores ($p = .896$). Separate analyses for simple Kanji ($p = .778$) and complex Kanji ($p = .823$) also found no significant differences. Although all groups showed learning gains compared to their low pre-test scores, adding AI-generated illustrations (MI) or combining them with drawing (MID) did not improve attainment over mnemonics alone (M).

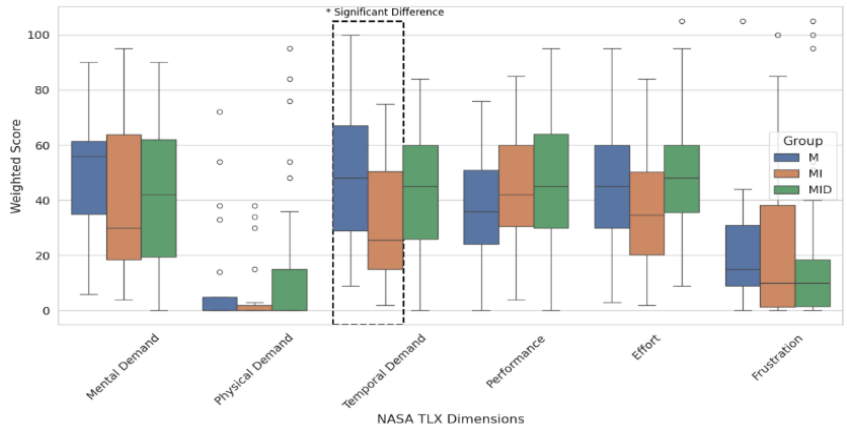

Figure 3. Weighted NASA TLX Scores Across Dimensions for Each Group

Cognitive workload analysis revealed a significant difference in total weighted NASA-TLX scores ($p = .039$). Post-hoc tests indicated that the MI group reported significantly lower workload than the MID group ($p < .05$), with interviews attributing this to the demanding nature of the drawing task. Qualitative feedback suggested that the drawing activity in the MID group was time-consuming, reducing the time available for learning. Further analysis of NASA-TLX dimensions (Figure 3) showed that the MI group also experienced significantly lower temporal demand than the M group ($p < 0.05$). Interviews supported this finding, as M group participants

reported feeling rushed, while MI participants stated that the illustrations helped them quickly connect Kanji characters to their meanings. For learning attitudes, no significant differences were observed in overall scores across the three groups ($p > 0.05$), indicating that the illustrations did not lead to a significant improvement in attitudes toward learning Kanji.

6. Discussion and Conclusion

This study examined the impact of AI-generated mnemonic illustrations on novice JFL learners to determine whether adding such illustrations to traditional mnemonics would positively influence learning outcomes. While the illustrations did not significantly improve overall Kanji attainment, the findings suggest that adding illustrations to text may not always enhance learning outcomes for logographic languages like Kanji, contrary to expectations based on theoretical frameworks. However, the results still support their use in Kanji learning because they significantly reduced perceived temporal demand. This was corroborated by the semi-structured interviews, as students in the MI group, who used illustrations, reported feeling less rushed compared to those using only mnemonics. The illustrations, however, did not lead to a significant improvement in overall learning attitudes toward Kanji.

Although direct comparisons between strategies showed no significant differences in attainment, learning gains were evident across all groups, as post-test scores improved from pre-test levels. This aligns with research by Hasanah et al. (2024), which reported notable improvements in Kanji attainment using visual image and pictograph strategies. Collectively, evidence indicates that visual aids such as mnemonic illustrations can positively influence aspects of the Kanji learning process, either by supporting direct attainment or by reducing perceived cognitive workload.

These results have practical implications for Kanji pedagogy. Students can use AI to generate personalized mnemonic illustrations tailored to factors such as age, gender, cultural background, and artistic preferences, making the learning experience more engaging and relevant. Teachers can also use this technology to design illustrations suited to specific student groups and incorporate them into classroom instruction, helping learners more effectively connect Kanji characters with their meanings. This study has certain limitations. It focused solely on identifying Kanji meanings, without addressing pronunciation or writing. The intervention period was limited to 20 minutes and covered only 40 Kanji, and long-term retention was not assessed. Future research could examine the method's effectiveness over longer periods, with more extensive Kanji sets, and explore its impact on other aspects of Kanji proficiency, including writing and pronunciation, as well as its long-term effects.

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